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Bovine Mastitis

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INTRODUCTION

This paper records observations made on a dairy herd over a period of 14 months. For six months preceding that period bacteriological examinations of milk samples had been made at regular intervals and many of the quarters infected with *Streptococcus agalactiae* had received chemotherapeutic treatment. For some time before any examinations were made and throughout the whole period covered by the observations the owner administered sulphanilamide orally to all animals showing clots in their milk.

The herd, which was free from tuberculosis and contagious abortion and had not been vaccinated against the latter disease, was housed in a large, unpartitioned modern building with standings for 180 cows, but fewer than that number were in milk at the same time. During the 14 months observation period animals that showed *Str. agalactiae* in their milk were kept together as a group in the shed and milked last. Priority in order of milking was given to the first-calf heifers, a number of which were milked in the standings, but the remainder of the herd, with few exceptions, was milked in a parlour. The treatment of quarters infected with *Str. agalactiae* was continued, at first by infusions of sulphonamide or diamino-diphenylsulphone preparations and latterly with penicillin. These treatments and the partial segregation of the *Str. agalactiae*-infected cows may have contributed to a lessening of the severity, and a reduction in the spread of *Str. agalactiae* infections.

METHODS

The fore milk of each lactating quarter was examined daily for clots by a member of the Institute staff, precautions being taken to reduce the risks of infection being carried from udder to udder. Quarter milk samples for bacteriological and other examinations were collected by members of the Institute staff and the milk from each quarter was examined at intervals of not longer than three weeks. Bacterial contamination at the collection of the samples was prevented as far as possible by washing the udders with hypochlorite solution and swabbing the ends of the teats, first with hypochlorite solution and then with methylated spirit, two or more swabs being used for teach teat. After collecting milk from each cow the hands of the operator were washed in hypochlorite solution and dried on a sterile towel. The milk was obtained before the afternoon milking and the samples were placed on ice and taken to the laboratory where they were held in the cold room until examined on the following morning.

Milk and milk diluted 1:10 were sown on the surface of sheep blood agar plates which were incubated for 48 hours. Colonies were classified according to their type and the numbers of each recorded. Representative colonies were transferred to suitable media for further tests. Precipitation with type B serum and biochemical tests were used for the identification of *Str. agalactiae*. The other streptococci were classified according to their biochemical reactions. Haemolysis by staphylococci was determined by Bryce & Rowntree (1936) methods but the seed material was obtained from a colony on a blood agar plate. For the last eleven months of the period staphylococcal colonies were tested for coagulase by the slide test described by Cadness-Graves, Williams, Harper & Miles (1943), rabbit plasma being used. The haemolytic staphylococci showed variations in the types of haemolysis produced but the majority of strains gave α β haemolysis while others showed β haemolysis and a few α haemolysis only. The great majority of the haemolytic strains were coagulase positive whereas the non-haemolytic staphylococci, with but very rare exceptions, were coagulase negative.

All staphylococci that produced haemolysis and were coagulase positive have been grouped together, but as the coagulase test was not applied throughout the whole period a number of strains that were coagulase negative may be included in this group. The haemolytic staphylococci found to be coagulase negative have been considered as a separate group. All organisms that produced a staphylococcal type of colony and were non-haemolytic have been grouped as non-haemolytic micrococci.

The udder corynebacteria, the bacteria described by Evans (1916); (1918), and by Bendixen (1933) were identified on the colonial appearance and, where doubt existed, identification was assisted by testing for catalase and by a microscopical examination of films prepared from the colonies.

The methods of identification described above were applied in full on every occasion when a bacterium was isolated.

A total cell count was made on each sample of milk by a method similar to that described by Prescott & Breed (1910). The modifications consisted in measuring 0·01 ml. of well-shaken milk with a standard platinum loop, and spreading this quantity evenly on an area of 1 square centimetre on a glass slide and allowing it to dry. The preparation was then treated with Neuman's solution. An appropriate number of fields were examined under the microscope and the cells present were counted. From these examinations an estimate was made of the number of cells present in 1 ml. of milk.

The Criteria of a Bacterial Infection of a Quarter.—With each type of bacterium a colony count equivalent to 100 or more per ml. of milk had to be obtained before cognizance was taken of it. It was very rare to obtain colony counts of less than 1,000 per ml. *Str. agalactiae*, *Streptococcus dysgalactiae* and *Streptococcus uberis* each had to be present at two out of three consecutive examinations before the milk was regarded as infected with the organism recovered. Other types of bacteria had to be present on three consecutive examinations before the milk was regarded as infected. The adoption of the above standards excluded from consideration many contaminating bacteria or bacteria that were but transitorily present in the milk.

Mixed infections were often present in the milk from a quarter and one species of organism at times replaced or overgrew another. In grouping the quarter milk samples according to their bacterial flora not more than two species of bacteria were considered for each quarter. Attention was confined to the two species originally considered likely to be the most pathogenic of those present and other species were disregarded. This arbitrary simplification was made to reduce the number of bacteriological groupings into which the quarter milk samples were arranged.

Raised Cell Count.—Milk samples were grouped into three main categories according to the total number of cells present per ml. of milk. These are:—

(1) Milk showing fewer than 250,000 cells;

(2) Milk showing 250,000 or more cells but fewer than 1,000,000 cells;

(3) Milk with more than 1,000,000 cells per ml.

All cells counts made within two weeks from the time of calving and from within four weeks from drying the cow off were disregarded. Categories (2) and (3) were each subdivided into three subcategories as follows:—

(*a*) "Transient" when the cells were present at one examination only;

(*b*) "Moderately persistent" when present at two or more consecutive examinations but falling below the critical number before the lactation ended or the observations terminated;

(*c*) "Persistent" when present at two consecutive examinations and at subsequent examinations until the end of lactation or until the observations ended.

In a number of cases the bacterial infection associated with a high cell count disappeared and the cell count dropped; these cell counts have been classified as "persistent." Cell counts frequently show marked fluctuations. It was therefore impossible for the milk samples from some quarters to conform exactly with the definitions of the categories and subcategories in which they were placed.

Clots in the Milk.—The clots formed in the fore milk were divided into two chief categories:—

(1) Few and small clots, and

(2) Multiple and large clots.

Each of these in turn was subdivided into "transient," "moderately persistent" and "persistent." In determining the subcategories into which milk showing clots would fall, conventions similar to those enumerated above for the subdivision of milk showing raised cell counts were followed. Although the milks were examined daily for clots the same degree of significance was given to the presence of clots in milk from a quarter irrespective of the number of times clots were detected in any one week, but when "few and small clots" were found on one day and "multiple and large clots" on another day of the same week the latter only were recognised for the data that are presented.

TABLE I

GENERAL INFORMATION COLLECTED FROM ALL QUARTERS

Infection	Cells: None	Cells: More than 250,000 but fewer than 1,000,000 per ml. Trans.	Mod. pers.	Pers.	Cells: More than 1,000,000 per ml. Trans.	Mod. pers.	Pers.	Clots: None	Few and small Trans.	Mod. pers.	Pers.	Multiple and large Trans.	Mod. pers.	Pers.
Str. agalactiae	2	1		1	3	8	31	6	4	5		1 (1)	5 (1)	23
+ *Str. dysgalactiae*							5	2						2 (1)
+ *Str. uberis*					(1)	1	2	1					2	1
+ coagulase positive haemolytic staph.			2	2		2	17 (1)	2	5 (1)	1		2	2 (1)	9 (1)
+ coagulase negative haemolytic staph.						1								(1)
+ non - haemolytic micrococci							1							1
+ udder corynebacteria			2 (3)	1 (1)	3	6 (1)	28	7	7	2		1 (1)	9	18
+ other bacteria							2			1				1
Total	2	1	4 (3)	4 (1)	6 (1)	18 (1)	86 (1)	18	16 (1)	9		4 (2)	18 (2)	55 (3)
%	1·6		11·7 (3·9) Mild or transient reaction			81·2 (1·6) More severe reaction		14·06		22·66 (2·35) Moderate or transient reaction			57·03 (3·9) More severe reaction	
Str. dysgalactiae				1					1				(1)	
+ udder corynebacteria	1		1		1	2	(1)	2	1				2	
Total	1		1	1	1	2	(1)	2	2				2 (1)	
%	14·29		42·86 Mild or transient reaction			28·57 (14·29) More severe reaction		28·57		28·57 Moderate or transient reaction			28·57 (14·29) More severe reaction	
Str. uberis				1			1	1	(1)					
+ coagulase positive haemolytic staph.				2		1	1		1	1		1	1	
+ udder corynebacteria	1						2	1				(1)		1
Total	1		3			1	4	2	1 (1)	1		1 (1)	1	1
%	11·11		33·33 Mild or transient reaction			55·56 More severe reaction		22·22		33·33 (22·22) Moderate or transient reaction			22·22 More severe reaction	
Coagulase positive haemolytic staph.	8		8	22	1	6 (1)	38 (1)	44	12 (3)	2 (2)		7 (1)	10 (1)	2
+ coagulase negative haemolytic staph.	2					2	1	2	1				(2)	
+ non - haemolytic micrococci	4		2	2	1	1	1 (2)	10	1 (1)				(1)	
+ udder corynebacteria	1	1	6	13 (1)	7 (1)	15 (1)	21	36	4 (5)	6 (1)		2 (1)	7 (1)	4
Total	15	1	16	37 (1)	9 (1)	24 (2)	61 (3)	92	18 (9)	8 (3)		9 (2)	17 (5)	7
%	8·8		37·1 (1·2) Mild or transient reaction			50·0 (2·9) More severe reaction		54·12		20·58 (8·24) Moderate or transient reaction			14·12 (2·94) More severe reaction	
Coagulase negative haemolytic staph.	1	1	1		1		1	4						1
+ non - haemolytic micrococci	11	(2)						12	(1)					
+ udder corynebacteria	6		1			1		6	(1)	1				
Total	18	1 (2)	2		1	1	1	22	(2)	1				1
%	69·23		15·39 (7·69) Mild or transient reaction			7·69 More severe reaction		84·63		3·84 (7·69) Moderate or transient reaction			3·84 More severe reaction	
Non-haemolytic micrococci	22	1	2	3 (1)			1	30						
+ udder corynebacteria	30	(2)	3 (5)	1	(1)	1 (2)	(1)	43	1			(1)		1
Total	52	1 (2)	5 (5)	4 (1)	(1)	1 (2)	1 (1)	73	1			(1)		1
%	68·42		13·16 (11·84) Mild or transient reaction			2·63 (3·95) More severe reaction		96·05		1·32 (1·32) Moderate or transient reaction			1·32 More severe reaction	
Udder corynebacteria + other bacteria	289	(13)	(32) (1)	1 (6)	(17)	(12)	1 (9)	359 1	1 (11)		(1)	(4)	1 (2)	(1)
Total	289	(13)	(33)	1 (6)	(17)	(12)	1 (9)	360	1 (11)		(1)	(4)	1 (2)	(1)
%	75·86		0·26 (18·11) Mild or transient reaction			0·26 (5·51) More severe reaction		94·4		0·3 (4·2) Moderate or transient reaction			0·3 (0·8) More severe reaction	
No bacteria	78	(1)			(1)		(1)	80					(1)	
%	96·3		(2·5) Mild or transient reaction			(1·2) More severe reaction		98·77					(1·23) More severe reaction	

Trans. = transient
Mod. pers. = moderately persistent
Pers. = persistent

The figures enclosed in brackets refer to those quarters where, in the compilation of this table, the bacteria were classified as not associated with the changes found in the milk.

The Relationship of a Raised Cell Count or of Clots in the Milk to the Bacteria Present in the Milk

In a preliminary arrangement of the data *Str. agalactiae, Str. dysgalactiae, Str. uberis* and all of the haemolytic staphylococci were regarded as associated with, and responsible for, both a raised cell count and the presence of clots, when the cultivation of the organism either coincided with, preceded or followed the milk changes by a short period. An association was also accepted when any of the above organisms together with milk changes were present at the first examination made on a quarter sample or at the first examination after calving. The bacteria were classified as "not associated" when the milk changes were found at two or more examinations before the bacteria were detected or when the milk changes were first shown after an infection had been established for six weeks or longer. When the only organisms found were the non-haemolytic micrococci or the udder corynebacteria, then an increase in the cell count or clots in the milk was classified as associated with the bacteria when the first appearance of the milk changes and the bacteria coincided, or, in the case of clots in the milk, when the bacteria were found at the first examination made after the detection of the clots.

All quarters infected with *Corynebacterium pyogenes* have been excluded.

The general information collected from all lactations followed for a period of 18 weeks or longer is presented in Table I which summarizes the data collected from 878 quarters, 120 of which were followed through portions of two lactations, the results from each of the two lactations being included in the table.

The udder streptococci, *Str. agalactiae, Str. dysgalactiae, Str. uberis* and the coagulase positive haemolytic staphylococci were each found in quarters that showed at some time during lactation a high percentage of milk samples with a raised cell count, and a high though lower percentage with clots. The quarters infected with the coagulase negative haemolytic staphylococci, the non-haemolytic micrococci, and the udder corynebacteria showed a relatively low percentage of milk samples with raised cell counts or clots. These bacteria though much less injurious than the udder streptococci or the coagulase positive haemolytic staphylococci cannot be dismissed as negligible, for at least 24 per cent. of quarters infected with one or other of them had milk showing some rise in the cell count. The significance of this 24 per cent. is obvious when it is realized that less than 4 per cent. of the quarters free from bacterial infection gave milk with a raised cell count. In compiling Table I the non-haemolytic micrococci and the udder corynebacteria were regarded as probably non-pathogenic and an association between infection and milk changes was not recorded unless the appearance of the milk changes and of the infection coincided. The assumption that the two micro-organisms were non-pathogenic may have been unjustified, therefore stress should not be placed on the frequent absence of association shown in the table.

To simplify comparisons the information contained in Table I is summarized in Table II. Quarters giving milk showing persistent or moderately persistent changes in the milk which were recorded in Table I as "associated" with bacteria and "not associated" are grouped together in Table II.

The information for the first, second and later lactations is grouped together in Table II. More critical comparative data are likely to be obtained on the effects of different infections by comparing the data from quarters in their first lactation. This information, in so far as a raised cell count in the milk is concerned, is given in Table III for quarters infected with pure cultures of the non-haemolytic micrococci and the udder corynebacteria. From the data presented in Tables II and III it may be concluded that an infection with any species of bacterium shown in these tables has some bearing on the aetiology of mastitis where a raised cell count is taken as indicative of disease.

Table III

Number and Percentage of Quarters in First Lactation Infected with Pure Culture of Non-Haemolytic Micrococci, Infected with Pure Culture of Udder Corynebacteria, and not Infected Respectively

	Total number of quarters infected	Cells above 250,000 but below 1,000,000		Cells above 1,000,000		Total with increased cell count	
		No.	%	No.	%	No.	%
Non-haemolytic micrococci	30	2	6·7	0	0	2	6·7
Udder corynebacteria ..	134	14	10·4	8	6·1	22	16·4
No bacteria	65	0	0	1	1·5	1	1·5

The part played by any bacterium in the aetiology of mastitis depends not only on the pathogenicity of the organism for the udder but also upon its infectivity for that organ. Table IV shows the total number and percentage of quarters infected with each of the bacteria. In Table I not more than two types of bacterial infection were recorded for each quarter but three and occasionally more types of bacteria were found in some quarters. The total number of quarters infected with certain bacteria, particularly those regarded as of low pathogenicity in compiling Table I, will therefore exceed the number shown in that table.

Table IV

Total Number and Percentage of all Quarters found Infected with Each Type of Bacterium

	Number	Per cent.
Str. agalactiae	128	14·6
Str. dysgalactiae	12	1·4
Str. uberis	13	1·5
Coagulase positive haemolytic staph.	199	22·7
Coagulase negative haemolytic staph. ..	35	3·9
Non-haemolytic micrococci	109	12·4
Udder corynebacteria	597	67·9

If it be accepted that a pure infection with a single type of bacterium elicits a reaction comparable to that which would be produced by an infection with the same bacterium plus any other of the bacteria placed lower on the list in Table I, the different bacteria found in the quarter milk samples from this herd can be arranged in order of frequency as each is potentially capable of causing reactions on the part of the udder. This arrangement is given in Table V.

Table II

Number and Percentage of Infected Quarters Showing Changes in Milk Secretion

Infection	Number of quarters infected	Infected quarters showing high cell count						Infected quarters showing clots					
		Moderately persistent and persistent						Moderately persistent and persistent					
		Above 250,000 but below 1,000,000		Above 1,000,000		Total with increased cell count		Few and small		Multiple and large		Total with clots	
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Str. agalactiae	128	12	9·4	106	82·8	118	92·2	9	7·0	78	60·9	87	67·9
Str. dysgalactiae	7	2	28·6	3	42·9	5	71·4	2	28·6	3	42·9	5	71·4
Str. uberis	9	3	33·3	5	55·5	8	88·9	3	33·3	2	22·2	5	55·5
Coagulase positive haemolytic staph. ..	170	54	31·8	90	52·9	144	84·7	11	6·5	29	17·0	40	23·5
Coagulase negative haemolytic staph. ..	26	2	7·7	2	7·7	4	15·4	3	11·6	1	3·8	4	15·4
Non-haemolytic micrococci	76	15	19·7	5	6·6	20	26·3	1	1·3	1	1·3	2	2·6
Udder corynebacteria	381	40	10·5	22	5·8	62	16·2	13	3·4	4	1·0	17	4·4
No bacteria	81	0	0	1	1·2	1	1·2	0	0	1	1·2	1	1·2

Comment on the quarters infected with the udder streptococci or the coagulase positive haemolytic staphylococci is unnecessary. When quarters infected with either the haemolytic coagulase negative staphylococci, the non-haemolytic micrococci or the udder corynebacteria are compared with quarters free from bacterial infection the latter show a much lower percentage of quarters producing milk with a raised cell count.

TABLE V

ESTIMATED NUMBER OF QUARTERS WITH CHANGES IN THE MILK THAT WOULD BE PRODUCED BY THE DIFFERENT BACTERIA IF PRESENT IN THE QUARTERS IN PURE CULTURE AND IN THE NUMBERS SHOWN IN TABLE IV

Number of quarters showing							
Over 250,000 cells		Over 1,000,000 cells		Clots		Large and multiple clots	
Coagulase positive haemolytic staph.	168	*Str. agalactiae*	106	*Str. agalactiae*	87	*Str. agalactiae*	78
Str. agalactiae	118	Coagulase positive haemolytic staph.	105	Coagulase positive haemolytic staph.	47	Coagulase positive haemolytic staph.	34
Udder corynebacteria	97	Udder corynebacteria	34	Udder corynebacteria	26	Udder corynebacteria	6
Non-haemolytic micrococci	29	*Str. uberis*	7	*Syr. dysgalactiae*	9	*Str. dysgalactiae*	5
Str. uberis	12	Non-haemolytic micrococci	7	*Str. uberis*	7	*Str. uberis*	3
Str. dysgalactiae	9	*Str. dysgalactiae*	5	Coagulase negative haemolytic staph.	5	Non-haemolytic micrococci	1
Coagulase negative haemolytic staph.	5	Coagulase negative haemolytic staph.	3	Non-haemolytic micrococci	3	Coagulase negative haemolytic staph.	

Table V shows that irrespective of the degree of the reaction on the part of the udder, *Str. agalactiae* and the coagulase positive haemolytic staphylococci are the two organisms primarily implicated, but as the severity of the reaction increases so do the streptococcal infections become the more common, and in the quarters affected with clinical mastitis, *i.e.*, producing milk with multiple and large clots, *Str. agalactiae* infections are twice as frequent as the staphylococcal. With regard to the other infections, the udder corynebacteria are the most important. This is emphasized in the classification that includes the least severe reactions, *i.e.*, quarters giving milk that shows a moderately persistent or persistent count of over 250,000 cells per ml. Accepting such a cell count as the criterion of mastitis the udder corynebacteria assume a position approximating to that of *Str. agalactiae*. They are obviously of much less importance in clinical mastitis, but a raised cell count is accepted without qualification by some workers as a criterion of mastitis and in such a case to ignore the possibility that it may be caused by udder corynebacteria is fallacious. Indeed Tables I to V show that any bacterial infection of the udder which is not entirely transient in character, such infections having been excluded from the tables, may be the cause of an udder reaction.

CONSIDERATION OF POSSIBLE CONTRIBUTORY FACTORS

Variations in the anatomy of the teat have been suspected to influence the susceptibility to mastitis. Thus Murnane (1940) estimated the size of the orifice by the diameter of the stream of milk capable of being withdrawn from it, and in the case of 30 animals studied, found no evidence that cows with large teat orifices were more susceptible than those with medium or small teat orifices. Murphy (1944) examined the teats of at least 87 cows and estimated the ease of milking by applying pressure with the fore-finger and thumb when the teat was full of milk. He classified teats as "patent" and "non-patent," the former being the more easily milked, and found a trend to exist towards a greater incidence of streptococcal and staphylococcal infections in quarters with patent teats. Espe & Cannon (1942) suggested that teats with everted and eroded orifices offered greater opportunity for infection of the quarters. The orifice was judged to be everted when an area of the epithelium lining the teat duct was visible around the external orifice and irregularities in the surface of this epithelium constituted erosion.

Records were made of certain physical properties of the teats and these are summarized in Table VI where, against each teat feature, is recorded the number and percentage of quarters producing milk with a moderately persistent or persistent raised cell count associated, as shown in Table I, with a bacterial infection. The quarters not falling into that category are shown separately. Comparable information is also given in Table VI for quarters that showed clots in the milk. The size of the teat orifice was assessed by visual examination only and the ease of milking by manipulation of the teats when full of milk. The data refer to one lactation for each quarter.

There is no evidence that the shape of the teat nor the external condition of the teat orifice had any bearing on susceptibility to mastitis. On the other hand, those cows that were classified as "easy milkers" had a higher incidence of mastitis than the "moderate" or "hard milkers." Therein these observations are in agreement with those made by Murphy (1944). Easily milked teats may favour more frequent bacterial contamination of the teat duct and cistern, thereby exposing the udder to a greater risk of contracting mastitis. In hand milking the easy milkers are the popular animals and selection, in the dairy breeds, has probably favoured the easily-milked animal. If it be proved that this characteristic predisposes the udder to mastitis, then in these days of machine milking it might be an advantage to eliminate the "easy milker" by selective breeding.

A number of workers, notably Hammond & Saunders (1923), Arnold & Becker (1936) and Klein & Woodward (1943) have found that cows with short dry periods produce milk below their potential capacity. The last-named authors examined a large number of lactations and found that as the length of the dry period increased from one to four months there was a progressive but diminishing increase in the milk yield. Thus cows dry from one to two months produced over 9 per cent. more milk than animals dry for one month, and cows dry for three to four months gave 1·4 per cent. more milk than those dry for two to three months. It seemed probable that the higher yields following the longer dry periods might in part be due to the udders having had a better opportunity to recover from any mastitis with which they happened to be affected.

Where histories for the last four to six weeks of one lactation and the first four to six weeks of the next lactation were available, together with information on the length of the dry period, the quarters were arranged in two groups, one group having a dry period of less than 15 weeks and the other with a dry period of 15 weeks or more. The incidence of mastitis in these two groups of quarters is shown in Table VII.

Quarters free from all evidence of mastitis, quarters showing a raised cell count but no clots, and quarters showing clots in the

TABLE VI

THE CORRELATION OF TEAT CHARACTERISTICS WITH MASTITIS ASSOCIATED WITH BACTERIAL INFECTION

Teat characteristics	Milk properties							
	Raised cell count associated with a bacterial infection		All other samples		Clots associated with a bacterial infection		All other samples	
	No.	%	No.	%	No.	%	No.	%
End sharply pointed	56	40·0	84	60·0	36	25·71	104	74.29
End bluntly pointed	91	31·82	195	68·18	52	18·18	234	81·82
End flat or concave	44	32·59	91	67·41	27	20·0	108	80·0
Orifice small	96	30·77	216	69·23	55	17·63	257	82·37
Orifice moderate	71	33·81	139	66·19	36	17·14	174	82·86
Orifice large	18	45·0	22	55·0	11	27·5	29	72·5
Eversion of orifice	46	30·26	106	69·74	25	16·45	127	83·55
No eversion of orifice	143	34·46	272	65·54	86	20·72	329	79·28
Hard milker	47	28·66	117	71·34	30	18·29	134	81·71
Moderate milker	71	28·51	178	71·49	37	14·85	212	85·15
Easy milker	75	50·34	74	49·66	49	32·89	100	67·11

TABLE VII

THE INFLUENCE EXERCISED BY EVENTS PRECEDING THE ONSET OF LACTATION ON THE INCIDENCE OF MASTITIS DURING THE SUBSEQUENT LACTATION

	Events preceding lactation	Total number of quarters	Percentage of quarter milk samples showing a raised cell count early in lactation	Percentage of quarter milk samples showing no increase in cells early in lactation	Percentage of quarter milk samples showing clots early in lactation	Percentage of quarter milk samples showing no clots early in lactation
Previous lactation	Dry period less than 15 weeks	227	45·4	54·6	19·4	80·6
	Dry period more than 15 weeks	231	47·2	52·8	29·0	71·0
	No mastitis at end of lactation	322	31·7	68·3	15·9	84·1
	Cell count raised before drying off	97	78·4	21·6	32·0	68·0
	Clots in milk before drying off	42	81·0	19·0	69·0	31·0
	Str. agalactiae infection before drying off	38	79·0	21·0	63·2	36·8
	Coagulase positive haemolytic staph. infection before drying off	72	88·9	11·1	40·3	59·7
	Udder corynebacteria infection before drying off	360	33·6	66·4	18·0	82·0

milk were noted during the four to six weeks before the end of lactation. These quarters were followed into the next lactation and the incidence of mastitis during the first six weeks of the lactation was recorded. The results obtained are shown in Table VII.

The incidence of mastitis as it is affected by a *Str. agalactiae*, a coagulase positive haemolytic staphylococcal or an udder corynebacterial infection of the quarter before the end of the previous lactation is also shown in Table VII.

Quarters that had the longer dry period showed no less mastitis than those with the shorter dry period.

A raised cell count in the milk before drying off materially increased the chances of the quarter giving milk with clots at the next lactation, and a still higher percentage (69 per cent.) of quarters that had shown clots before drying off gave clotted milk early in the next lactation.

Infection at the end of lactation with either *Str. agalactiae* or the coagulase positive haemolytic staphylococcus is shown to be followed by a high incidence of quarters giving milk with clots—63·2 and 40·3 per cent. respectively. In comparison, an infection with the udder corynebacterium before drying off is followed by much less disturbance, 18 per cent. of the quarters showing clots in the milk early in the next lactation.

It is generally agreed that older animals suffer more from mastitis than younger animals. The data presented in Table VIII show the herd examined to be no exception. In compiling the table the bacteria have been arranged in the same order of pathogenicity as was arbitrarily adopted for Tables I and II. Where more than one species of bacterium was present only that regarded as the most pathogenic has been considered.

It is clear from Table VIII that the incidence of *Str. agalactiae* and of the coagulase positive haemolytic staphylococcal infections, and the mastitis associated with each infection, was highest in the older cows. Infections with *Str. dysgalactiae* and *Str. uberis* were few in number but with neither is there a suggestion of an increased incidence in the later lactations.

When the quarters infected with bacteria listed higher in the table than a particular infection under consideration are excluded, it is found that the percentage of quarters infected with the coagulase negative haemolytic staphylococci rose at the second lactation but fell at the third and subsequent lactations, reaching a point even lower than at the first lactation; the percentage of quarters infected with non-haemolytic staphylococci dropped progressively as the lactation age increased. The incidence of the udder corynebacteria, on the other hand, rose progressively. Thus of the quarters free from infection with other bacteria 67, 88 and 97 per cent. were infected with udder corynebacteria at the first, second, third and later lactations.

Christiansen & Nielsen (1943) found that on injuring the teat orifice quarters were more readily infected by the application of streptococci to the outside of the teats. The streptococcus they employed was of greater virulence than *Str. agalactiae*. Bendixen (1934) reported similar results where *Str. agalactiae* was the organism used.

The Report of the Imperial Bureau of Animal Health, "Modes of Spread of *Streptococcus agalactiae* Infection in Dairy Herds" (1944) showed that very often *Str. agalactiae* could be isolated from the skin of the teats of udders producing milk free from the infection and that some animals carried large numbers of *Str. agalactiae* on the skin of the teats and frequently the skin of these heavily-contaminated teats had abrasions or sores.

In view of the above findings and the commonly accepted connection between teat lesions and mastitis, the injuries to the teats and quarters were noted. When the milk from the quarter contained neither streptococci nor coagulase positive haemolytic staphylococci before injury occurred, the results of the routine bacteriological examinations for these organisms up to and including the second examination made after the teat injury healed, have been reported in Table IX.

Table IX demonstrates a trend for *Str. agalactiae*, but not for coagulase positive haemolytic staphylococci, to infect the milk when the teat is injured. There was no suggestion that superficial injury to the quarters, in the absence of injury to the teat, rendered the quarter more susceptible to bacterial infection. It should, however, be noted that wounds of the teat and of the udder were treated with sulphonamide ointments and this may have reduced the incidence of bacterial infections.

A record was kept of all quarters that showed redness, warmth and tenderness accompanied by swelling. These signs of acute inflammation were classified according to the degree of the re-

TABLE VIII

THE INCIDENCE OF BACTERIAL INFECTIONS AT DIFFERENT LACTATIONS

Where more than one infection was present all but one have been disregarded; the infection selected for inclusion in the table was the one coming highest in the list of bacterial infections shown in the table

Infection	• Quarters showing cell count above 250,000						Quarters showing cell count below 250,000						All quarters					
	First lactation		Second lactation		Third and later lactations		First lactation		Second lactation		Third and later lactations		First lactation		Second lactation		Third and later lactations	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Str. agalactiae	19	6·29	13	7·7	94	23·1	1	0·33	—	—	1	0·25	20	6·62	13	7·7	95	23·35
Str. dysgalactiae	3	0·99	1	0·59	2	0·5	1	0·33	—	—	—	—	4	1·32	1	0·59	2	0·5
Str. uberis	1	0·33	4	2·37	3	0·74	—	—	—	—	1	0·25	1	0·33	4	2·37	4	0·99
Coagulase positive haemolytic staph.	21	6·95	23	13·61	111	27·27	—	—	2	1·18	13	3·19	21	6·95	25	14·79	124	30·46
Total infections with the more pathogenic bacteria	44	14·56	41	24·27	210	51·61	2	0·67	2	1·18	15	3·69	46	15·22	43	25·45	225	55·3
Coagulase negative haemolytic staph.	1	0·33	5	2·96	2	0·49	8	2·65	9	5·33	1	0·25	9	2·98	14	8·29	3	0·74
Non-haemolytic micrococci	14	4·64	7	4·14	3	0·74	33	10·93	9	5·33	10	2·46	47	15·57	16	9·47	13	3·2
Udder corynebacteria	29	9·6	17	10·06	46	11·31	106	35·1	68	40·24	115	28·26	135	44·7	85	50·3	161	39·57
No bacteria	3	0·99	—	—	—	—	62	20·53	11	6·51	5	1·23	65	21·52	11	6·5	5	1·23

• All quarters showing transient, moderately persistent or persistent cell counts are included.

TABLE IX

THE ASSOCIATION BETWEEN INJURY TO THE TEAT AND BACTERIAL INFECTION OF THE MILK: AND THE ASSOCIATION BETWEEN INJURY TO THE QUARTER, EXCLUSIVE OF TEAT INJURY, AND BACTERIAL INFECTION OF THE MILK

	Lesion healed under one week		Lesion healed under two weeks		Lesion healed under three weeks			Lesion took longer than three weeks to heal		
	No infection followed	Infection followed *Str. agal.*	No infection followed	Infection followed *Str. agal.*	No infection followed	Infection followed *Str. agal.*	Infection followed *Coag. pos. haem. staph.*	No infection followed	Infection followed *Str. agal.*	Infection followed *Str. uberis*
Teat—										
Scratch	3	1	3		2			5		
Laceration without injury to canal or sphincter	8		1	2		2		3	2	
Laceration with injury to sphincter					1				1	1
Laceration with injury to canal and sphincter						1				
Quarter—										
Bruise	2		2							
Bruise with blood in milk	3		1				1	1		
Laceration of skin	2		4							
Laceration of skin with blood in milk	1		1		2			1		
Wound extending into glandular tissue			1							

TABLE X

QUARTERS THAT WERE AFFECTED WITH ACUTE INFLAMMATION BUT WHERE NEITHER TRAUMA OF THE QUARTER NOR OF THE TEAT WAS OBSERVED

The figures enclosed in brackets show the number of udders affected when this number was less than the number of quarters

Degree of inflammation	Bacteria present in milk before or at the time the reaction occurred					No bacteria present in the milk before reaction, but bacteria followed at or about the time of the reaction			No bacteria present in the milk when reaction occurred and none found at two examinations after reaction had subsided
	Str. agal.	*Str. dysg.*	*Str. uberis*	*Coag. pos. haem. staph.*	*Udder corynebacteria*	*Str. agal.*	*Str. uberis*	*Non-haem. micrococci*	
Mild	1			1	2				
Moderate	7 (4)	3	1	6 (4)	3 (2)	1*	1†	1‡	1
Severe	2			2	1				
Total reactions	10 (7)	3	1	9 (7)	6 (5)	1	1	1	1

* The quarter showed *Str. agalactiae* in enrichment media only at time of the reaction, at the next examination innumerable bacteria were present.

† The quarter showed no bacteria at the first examination following the reaction, but at a second examination on the fifth week large numbers of *Str. uberis* were present.

‡ On the week following the reaction the quarter showed a small number of haemolytic staphylococci and udder corynebacteria; three weeks later these organisms had disappeared but over 10,000 non-haemolytic micrococci per ml. of milk were found.

action as "mild," "moderate" and "marked." The quarters showing these reactions and the results of the bacteriological examinations of the milk from these quarters are given in Table X. Quarters that suffered from wounds or trauma have been excluded from the table.

Altogether 314 quarters were infected with the udder streptococci or with coagulase positive haemolytic staphylococci and 558 quarters were not infected with these organisms. 7·3 per cent. of the former and 1·8 per cent. of the latter showed an acute inflammation. Among this latter group are included the quarters infected with udder corynebacteria only and of these, 1·5 per cent. showed acute inflammation. All the quarters that had a bacterial infection were not infected throughout the whole period of the observations. It may therefore be concluded that in this herd quarters infected with bacteria that cause a high incidence of mastitis, as revealed by the appearance of clots in the milk, are the most likely to show evidence of acute inflammation.

DISCUSSION

The evidence furnished by the present examinations does not suggest that in this herd any infective agent other than bacteria was the cause of mastitis. Probably because of the irregular results of infection experiments and the widely-held view that faults in milking and injuries to the teats and udder are connected with the occurrence of mastitis it has been freely postulated that predisposing causes play an important part in rendering the udder susceptible to bacterial infection and mastitis. In this connection emphasis has been placed by some workers on the importance of a so-called non-specific mastitis. Hastings & Beach (1937) found evidence of mastitis in the absence of a *Str. agalactiae* infection and regarded the udder as affected with a non-specific mastitis. Petersen, Hastings & Hadley (1938) described a similar condition, stating that the only organisms regularly found in the milk were diphtheroids, micrococci and staphylococci. They dismiss the organisms as of no aetiological importance; even the staphylococci are not considered significant, the authors apparently regarding the staphylococci as the cause of an acute mastitis only. To explain the disease they postulated a filtrable virus and in support thereof quoted the production of a non-specific mastitis in five out of seven quarters of two heifers where the quarters had been inoculated intraparenchymatously before calving with material from diseased udders that were not free from bacterial infection. The diagnosis of non-specific mastitis in the quarters of the experimental heifers was made when the animals were slaughtered, in one case 18 weeks and in the other 21 weeks after calving, but in the absence of streptococcal infections no notice was taken of the bacterial flora of the quarters. This work, ignoring the rôle that infection with staphylococci, micrococci and diphtheroid bacteria may play, cannot be accepted as evidence that a filtrable virus causes mastitis. In a later publication Petersen & Hastings (1939) concluded that non-specific mastitis lowered the resistance of the mammary gland to *Str. agalactiae* and suggested that non-specific mastitis was a primary condition and *Str. agalactiae* but a secondary invader. Their conclusion was based on what appeared to be the relatively high susceptibility of quarters affected with non-specific mastitis to experimental exposure to *Str. agalactiae*. The experiments were not controlled and of the 34 quarters exposed to infection all showed non-specific mastitis. "Non-specific mastitis" need not affect all quarters of the same udder (Hastings & Beach, 1937), and it is unfortunate that udders with both normal and affected quarters were not used in the experiments. Hastings & Petersen (1940), con-

tinuing their observations, followed a group of eleven cows over three lactations and in the second and third lactations found mastitis was occurring although no streptococci were present. At the commencement of the study a bacteriological examination was made for streptococci only; later examinations were made for other bacteria. No details are given but the authors concluded that "No other organism was found with sufficient consistency and in sufficient number to be apparently responsible for the changes noted in the milk and in the structure of the udder." In this publication no suggestion is made of a virus being implicated.

Hastings, Beach & Johnson (1943), working on a herd of cows into which a *Str. agalactiae* infection was accidentally introduced, attempted to find a correlation between udders showing evidence of mastitis and the susceptibility of these udders to *Str. agalactiae* infection spreading in the herd, but none was found. In three herds they found that in the absence of a *Str. agalactiae* infection chronic mastitis occurred but it rarely led to macroscopic changes in the milk or to the permanent loss of a quarter.

Malcolm, King & Campbell (1944) and Malcolm & Campbell (1946) have drawn attention to mastitis when streptococci, *Corynebacterium pyogenes* and coliform bacteria could not be incriminated and where staphylococci could generally be excluded, and Malcolm *et al.* (1944) appeared to favour the hypothesis that the disease might initially be due to "some unknown agent, specific or non-specific in nature" and that the streptococci and staphylococci were secondary invaders, "commensals or contaminants, which are able to gain a foothold owing to the abnormal conditions." The authors made no suggestion regarding the nature of the unknown agent nor how search should be made to find and identify it.

Proof that a low-grade mastitis or a bacterial infection predisposes the udder to *Str. agalactiae* infection would be interesting but it is not likely to contribute anything useful to the prevention of the disease caused by that organism. The eradication of *Str. agalactiae* would be simple compared with the prevention of infections with all other species of bacteria and the prevention of all low-grade mastitis.

While there is no evidence that a filtrable virus is responsible for or associated with the cases of mastitis generally occurring in the field, Baker & Little (1946) found a filtrable virus implicated in a febrile disease encountered in one herd and accompanied by the appearance of blood in the milk and in some cases other definite changes in the milk diagnostic of mastitis of varying degrees of severity. The virus-like agent recovered from the blood-stained milk was transmissible to laboratory animals and to the chick embryo. The disease was reproduced in lactating cows by the subcutaneous inoculation of infective material. Furthermore, neutralizing antibodies developed in experimental animals. Clinically, this disease differed from the mastitis caused by bacterial infections of the udder and would appear to be a rarity. As pointed out by Little (1946) the disease described by Baker & Little in no way lessens the importance attributed to bacteria in mastitis and it does not detract from the view that bacteria generally, if not invariably, colonize in the udder independently of the presence of virus.

The investigations reported in this paper confirm the widely accepted belief that mastitis is a bacterial disease. They demonstrate the great aetiological importance of *Str. agalactiae* and the coagulase positive haemolytic staphylococci and indicate that all bacteria commonly encountered in the milk may each produce some degree of udder injury.

The literature shows that from time to time many different bacteria have been implicated in clinical mastitis. It may therefore be concluded that the control of mastitis is essentially a bacteriological problem in which certain bacteria play a predominant part while others are of lesser importance.

The control of bacterial infections of the udder is considered under the following headings:—

(1) Eradication of a specific infection from the herd.
(2) Management and hygiene.
(3) Immunization.
(4) Chemotherapy.

Eradication

Str. agalactiae infection has been eradicated from a limited number of herds in Britain, Europe and America. Some herds are fortunate in that they are free from the infection. Eradication is scientifically a sound policy as the udder is the only known permanent reservoir for the streptococci and in the absence of udder infections those *Str. agalactiae* that may be found on the skin and in the environment of the cow would be expected to die out. The practicability of maintaining herds free from the infection has been well demonstrated in Connecticut, U.S.A., where a total of 85 herds have been under observation for periods of one to twelve years after they were first regarded as being free from *Str. agalactiae*. Seventy-two of these herds have remained free from *Str. agalactiae* infection, one has been negative for a period of twelve years, one for ten years, one for six years, 18 for three to five years, 18 for two to three years and 33 from one to two years (Plastridge, 1946).

Eradication of the coagulase positive haemolytic staphylococci, *Str. dysgalactiae* and *Str. uberis* does not appear to be feasible, the ecology of these organisms indicating that each can exist independently of the bovine udder. The elimination of cows with infected udders would therefore not succeed in a complete suppression of fresh udder infections though it might reduce their number.

Management and Hygiene

In New Zealand, Ward (1944) has studied alleged predisposing causes to mastitis including the claim often made that certain types of milking machine contribute to a higher incidence of disease. The incidence of clinical mastitis was recorded in machine milked herds during 1942-43 and 1943-44. In the first year 1,099 herds and in the second year 1,787 herds were studied. Five main types of milking machine were in use. In the first year the smallest number of herds milked by any one of these five types of machine was 96 and in the second year 182. Each year there was a group of herds where a number of different types of less popular machines were in use. The data collected failed to "reveal any significant reduction in mastitis as associated with any particular type of milking machine." It does not follow, however, that improvements in the technique of machine milking will not be shown to reduce the incidence of the disease but it may be observed that Ward & Castle (1945) over a three-year period found no appreciable difference in the incidence of clinical mastitis in eight herds where the condition and performance of the milking machines were good compared with ten herds where the condition and performance of the milking machines were but average or poor.

In some machine milked herds hand stripping is practised; in others it is not. Schmidt-Hoensdorf & Schmidt (1932) claimed that in an experiment when ten cows were infected with streptococci and machine milked the five stripped by hand suffered from less severe mastitis than the five that were not hand stripped. Wallis, Eckles, Petersen & Macy (1932) examined quarter milk samples from a small number of cows which over six to eight days were alternately stripped for two days after machine milking and not stripped for two days. They found no evidence that alternate stripping and non-stripping exerted any influence on the bacterial flora of the quarters. Woodward (1936) made observations on 14 machine milked cows each of which was followed through at least one lactation when she was milked "incompletely" by removing the machine without manipulation of the udder, and one lactation where the milking was "complete," the udder being manipulated before the removal of the milking machine. With incomplete milking it was estimated that an average of 1·2 lb. of milk were left in the udder which would have been removed had milking been complete. No evidence was found that incomplete milking increased the number of cells, the total number of bacteria or the streptococci in the milk. Schalm & Mead (1943) examined the milk from eight cows for 13 weeks, during which time an average of 2 lb. of milk were left in the udder at each milking; four cows milked by machine but not hand stripped during a period of 17 weeks were also followed. In both groups those quarters infected with *Str. agalactiae* or with staphylococci appeared to become affected sooner or later with a more severe form of mastitis but the severity of the mastitis was not related to the quantity of the milk estimated to have been left in the udder after milking.

In dairy practice stripping has not been proved better than non-stripping. This point was investigated by Ward & Castle (1945). Their enquiries included 32 herds each of which was followed over a three-year period and the same incidence of clinical mastitis was found irrespective of whether non-stripping or hand stripping was practised.

Drying cows off at the end of lactation by abruptly interrupting and stopping all milking has been advocated in preference to the general practice of incomplete milking at lengthening intervals (Wayne, Eckles & Petersen, 1933; Wayne & Macy, 1933; Steyn, 1940). The advantages claimed for the former method include the more rapid involution of the udder which gives the gland a longer period for rest and development before a new lactation starts and it is suggested that thereby the udder may be more able to overcome and resist mastitis. But neither practice has been shown superior to the other in so far as reducing the incidence of mastitis is concerned. Furthermore, variations in the length of the dry period compatible with economic milk production have not been shown to influence susceptibility to mastitis.

A system of hygiene capable of reducing the dissemination of bacteria to a very low level would have to be most conscientiously applied to achieve that objective. A scrupulous and punctilious application of an adequate hygienic routine would probably never be carried out regularly and fully in the cowshed where the

environment does not favour the self-imposed discipline necessary for the observance of detail and where infringements are not followed by consequences that lead to their detection. Anyone who has criticized his own behaviour and observed that of others in the cowshed must realize how often it was inconsistent with the conviction that mastitis is an infectious disease and milk the chief vehicle for transmitting infection.

Hypochlorite disinfectants are commonly used in washing udders, and the teat cups of the milking machine between the milking of individual cows; but effective disinfection of the milk escaping from the udder is impracticable. At the withdrawal of milk from the udder by hand, whether at stripping or at the examination of fore milk for the presence of clots, milk contaminates the hands and the environment of the cow; on the removal of the teat cups from the udder some milk is often splashed on the floor; a few animals in anticipation of being milked leak milk from their teats. The foregoing are among the common ways in which milk contaminates the environment. Where a milking parlour is used and the cows do not lie where they are milked the udder should be exposed to less contamination than where milking is carried out in the stalls. The dissemination of bacteria in the milk cannot be eliminated; whether it can be reduced sufficiently to lower the incidence of mastitis has still to be demonstrated. The investigations reported by the Imperial Bureau of Animal Health (1944) showed no consistent difference in teat skin infections with *Str. agalactiae* between herds where disinfectants were used in the washing of the udders and those where no disinfectants were employed. In making these comparisons apparently no notice was taken of other practices which might render the comparison valueless, *e.g.*, the use of the fore milk cup and hand stripping, which are commonly carried out without washing or disinfecting the hands between the manipulation of individual udders.

Although mastitis is acknowledged by veterinary opinion to be an infectious disease its infectivity is treated lightly. Thus in the routine clinical examination of herds in Britain carried out by the veterinary inspectors of the Ministry of Agriculture the inspector is not required to, and does not in fact, wash or disinfect his hands between the palpation of individual udders. The disregard of the infectious nature of the disease in practice may be unavoidable but it is also symptomatic of the general attitude to mastitis, and to expect cow attendants in the commercial dairy to maintain high standards of "bacteriological" hygiene is unreasonable. To establish the significance of hygiene comparative critical trials would have to be made. These are not possible under normal dairying conditions. It is doubtful whether they could be properly conducted experimentally, but even if mastitis could be controlled experimentally by a system of hygiene, the value of hygiene would be limited because of the difficulties in ensuring its adoption in the field.

The importance of hygiene is often stressed in scientific and semi-popular papers dealing with the control of mastitis. In this connection the surveys made by the New Zealand Dairy Board (1945) are interesting. Their investigation extended over three years and included 16 herds where the cowshed hygiene was good, ten herds where it was average and six where it was poor. No significant difference in the incidence of clinical mastitis was shown between the herds where the different standards of hygiene prevailed. It was, however, pointed out that the shed hygiene described as good might be relatively poor compared with the optimum standard for the control of mastitis.

Immunization

The inflammatory reaction caused by a bacterial infection of the mammary gland may occur in response to the noxious action of the products of bacterial growth in the udder secretions; it may be excited by the multiplication of the organisms within the cells of the acini and ducts and their supporting tissues.

A streptococcal infection of the udder has not been produced by the subcutaneous or intravenous inoculation of the bacteria. Christiansen & Nielsen (1934) succeeded in setting up infection of the udder by inoculating large doses of a streptococcus culture directly into the arterial blood supplying that organ. They failed, however, to establish infection with doses 500 to 25,000 times larger than that which produced mastitis when inoculated into the udder by way of the teat. The experiments are interesting in that they show the greater susceptibility of the udder to a streptococcus when the attack is launched from the duct and acinar system rather than by a direct invasion of the udder tissues from the bloodstream. The organism they used was not *Str. agalactiae*, but β haemolytic, fermented sorbite and was "strongly pathogenic for white mice." These are the characters of a Lancefield Group C streptococcus and this organism, though it is not infrequently incriminated in mastitis, cannot be used to demonstrate how the udder would react to comparable experimental inoculations with *Str. agalactiae*, but as that organism is of much lower pathogenicity it is unlikely that it would invade the udder from the blood stream any more readily. There is no proof that in *Str. agalactiae* mastitis an active invasion of the udder tissues by the bacteria occurs independently of bacterial growth within the lumen of the ducts and acini of the gland. Anatomically the acini of adjacent lobules of the two quarters on the same side of the udder are in as intimate juxtaposition as are the acini of adjacent lobules of the same quarter. The latter are contiguous through their duct system whereas the former are not. If *Str. agalactiae* were capable of invasion and penetration through the tissues it might be anticipated that following upon the infection of a quarter there would be a tendency for the adjacent quarter on the same side to become infected. Infection of quarters on the opposite side of the udder could not occur by direct tissue invasion, each side of the udder being separated from the other by fibrous, elastic and connective tissues and each having a separate blood and lymph system. In the herd under consideration ten animals showed infection with *Str. agalactiae* in two quarters; in two instances these quarters were on the same side; in the remaining eight cases they were on opposite sides. Comparable data from another herd showed ten infected quarters on the same side and 18 on the opposite side of the udder. With coagulase positive haemolytic staphylococcal infections in the first herd it was found that four animals showed infection of two quarters on the same side and 13 infection in two quarters on opposite sides. If infection occurred by way of the teat only, then among those cows with two infected quarters, one cow with infected quarters on the same side might be expected for every two cows each with infected quarters on opposite sides of the udder. The distribution of the *Str. agalactiae*-infected quarters actually found, indicates that infection spreads to a second quarter of the same udder via the teat and lends no support to the hypothetical direct penetration of *Str. agalactiae* through the udder from one quarter to another, nor for that matter does it appear likely that the haemolytic staphylococci, which have greater tissue invasiveness than *Str. agalactiae*, spread from quarter to quarter except by way of the teat.

Immunization against the common mastitis bacteria may therefore present a problem of unusual difficulty, not only because immunity to streptococcal and staphylococcal infections in general is not readily produced or demonstrated, but because outside the body tissues in the duct and acinar system of the udder a bacterial population is built up in the medium of the udder secretions, and although some of the mastitis bacteria themselves may be non-pathogenic when introduced directly into the tissues the combined action of bacteria and altered secretions is noxious. Two problems of immunity therefore present themselves. These are:—

(1) Is it possible to raise the immunity so that immune bodies are present in the milk which will inhibit the growth of mastitis bacteria or destroy these bacteria while they are still in the strictest sense outside the body?

(2) Is it possible to raise the resistance of the udder tissues to withstand injury from bacteria or bacterial products acting on the tissues from the lumen of the acini or ducts?

The greatest benefit would accrue from an inhibition and destruction of the bacteria in the lumen of the ducts and acini. The growth even of non-pathogenic organisms in these loci, should they cause clotting of the udder secretions, may be injurious because of mechanical obstruction of ducts and acini.

According to Howe (1925) 100 c.c. of cow's plasma contains 3·5 grammes of total globulin of which 0·78 grammes are euglobulin. Smith (1946), by electrophoretic analysis, has shown that globulins constitute 10 per cent. of the proteins of whey. As whey contains approximately 0·5 per cent. protein each 100 c.c. of milk will have 0·05 grammes of globulin or 70 times less globulin than blood plasma. It is open to question whether the concentration of antibody or of phagocytic cells in normal milk in the udder of a highly immunized animal would be sufficient to inhibit or contribute to the inhibition of bacteria in the milk. The udder secretions in the pregnant heifer and the dry cow are rich in globulin (Woodman & Hammond, 1923). In mastitis, from whatever cause, the secretion approaches nearer to the composition of the blood serum and it contains increased numbers of phagocytic cells. In the immunized animal, or in the non-immunized animal, the mechanisms for clearing bacteria from the udder might be most effective during the dry period and during lactation if some degree of mastitis were already present. Unfortunately udder infections generally survive the dry period and there is at present no evidence to encourage the hope that increased globulin or antibody, or increased numbers of phagocytic cells in the milk will assist in overcoming bacterial infections.

The bactericidal action of normal milk is well recognized and this action is independent of complement that may be present in the milk (Hannsen, 1924; Jones & Little, 1927; Jones & Sims, 1930). Jones & Little (1927) and Jones & Sims (1929) showed mastitis streptococci, presumably *Str. agalactiae*, to be susceptible to the bactericidal action but the former authors were unable

to demonstrate any enhanced bactericidal properties in milk from cows that had suffered from several attacks of streptococcal mastitis, or in milk from animals that had been vaccinated with the streptococci. Jones & Little (1934) reported a cow suffering from a staphylococcal infection of one quarter where the milk from the three normal quarters was bactericidal for staphylococci but milk from the infected quarter was not. Moreover the dilution of the normal milk with 25 per cent. of the secretion from the infected quarter, or with the same proportion of blood serum from the cow, destroyed the bactericidal action. Burkey, Meigs, Sanders & Rogosa (1938), however, state there is a tendency for the bactericidal properties of the milk to increase, in the earlier stages of mastitis, as the leucocytes in the milk increase.

It is clear that the protective mechanism of the udder to bacterial infection offers a field of more than ordinary complexity that has been but little explored.

A practical difficulty confronting experiments in which immunity or resistance of the udder is tested *in vivo* is the great variability shown by different udders and by different quarters of the same udder to infection. Jones & Little (1934) reviewed the literature on the experimental production of mastitis and noted the irregularities in the results reported where moderate doses of streptococci were introduced into the udder via the teat canal. In their own experiments with small doses of the organism primary inoculation did not establish permanent infection but permanent infections were often produced by repeated inoculations carried out at intervals of a few days. They suggested that the udder became sensitized to the streptococci and because of the sensitization infection was able to establish itself. The alleged sensitization was considered harmful in a manner comparable to that in which Rich (1944) regards sensitization to the tubercle bacillus and to other micro-organisms as harmful. Interesting as the suggestion is, no proof was furnished that a sensitization did occur and no means of identifying its presence or absence was disclosed. The irregularity of the response of different quarters of the same cow to the same experimental infections indicates that even if sensitization does occur the problem of why one quarter should become infected while another escapes is no nearer clarification. Fewer attempts have been made to study the experimental production of staphylococcal mastitis but there is no reason to believe that this form of the disease would be reproduced with greater regularity than a *Str. agalactiae* mastitis.

To acquire elementary but fundamental knowledge of the protective capacities of the udder, actual and potential, inherent or acquired, against bacteria, careful experiments would have to be made on animals maintained in a suitable environment, an environment where the accidental exposure of the udder to the infection studied was prevented.

Chemotherapy

To-day the literature on mastitis shows that chemotherapy holds out the best prospects of immediate relief in individual cases of streptococcal mastitis. The systematic treatment of all *Str. agalactiae*-infected animals in a herd may prove not only of value in the treatment of individual cows but also in the elimination of that infection from herds. Whether systematic treatment based on the results of bacteriological examinations made at short intervals will become a practical method for the control and possible eradication of *Str. agalactiae* infections time will tell. The success in the use of penicillin and the introduction of the penicillin bougies for insertion into the teat canal (Barnum, 1947) and other methods simplifying administration of the drug suggest that the regular treatment of all cows in a herd may come within the range of general practice.

As the value of antibiotic drugs is increased so may the chemotherapeutic control of mastitis be expected to extend. Chemotherapeutic trials may be carried to a satisfactory conclusion by using infected animals in the field. Research on management, hygiene and immunization requires cattle expressly kept for these several purposes.

Summary and Conclusions

Investigations over a 14 months period on a dairy herd are recorded.

Four degrees of mastitis were recognized. These are:—

1. Quarters producing milk with a persistent or moderately persistent cell count of 250,000 or more cells but fewer than 1,000,000 cells per ml. of milk.
2. Quarters producing milk with a persistent or moderately persistent cell count of 1,000,000 or more cells per ml. of milk.
3. Quarters producing milk containing few or small clots which were not transient.
4. Quarters producing milk containing large and multiple clots which were not transient.

The different degrees of mastitis were associated with infection with one or more types of bacteria. A preliminary arrangement of these bacteria according to an arbitrarily selected descending order of pathogenicity was made as follows: (1) *Str. agalactiae*, (2) *Str. dysgalactiae*, (3) *Str. uberis*, (4) coagulase positive haemolytic staphylococci, (5) coagulase negative haemolytic staphylococci, (6) non-haemolytic micrococci, and (7) udder corynebacteria. This arrangement was used to give priority of consideration to the bacteria regarded as the more pathogenic when more than one type of bacterium was found in milk samples from a quarter.

Infections with, and mastitis caused by, *Corynebacterium pyogenes* have been excluded from consideration.

Applying the above order of pathogenicity it appeared that a pure infection with any type of bacterium was capable of producing as severe a reaction as infection with that bacterium plus any other bacterium placed lower in the scale of pathogenicity.

The infectivity of the different types of bacteria varied. Arranged in descending degrees of infectivity the order is (1) the udder corynebacteria, (2) the coagulase positive haemolytic staphylococci, (3) *Str. agalactiae*, (4) non-haemolytic micrococci, (5) coagulase negative non-haemolytic staphylococci, (6) *Str. uberis* and *Str. dysgalactiae*.

From the number of quarters found infected with each type of bacterium the number of cases of mastitis that could have been caused by a pure infection with each type of bacterium was estimated. This showed that depending upon the different criteria accepted as constituting the lowest limit of mastitis, so the incidence of mastitis caused by particular infections varied.

When all affected quarters, both those giving milk with a count of 250,000 cells or more and those showing clots, are grouped together the coagulase positive haemolytic staphylococci are found associated with the greatest number of affected quarters. *Str. agalactiae* and then the udder corynebacteria infections come next in the order of frequency. The three types of bacteria account for 87 per cent. of affected quarters, the udder corynebacteria alone being responsible for 22 per cent. of the total number of affected quarters.

Where quarters producing milk with a total cell count of 1,000,000 per ml. and quarters with milk showing clots are considered the coagulase positive haemolytic staphylococci and *Str. agalactiae* are found to be equally important, between them accounting for 78 per cent. of all affected quarters. The udder corynebacteria, though still responsible for more cases of mastitis than the remaining bacteria, are associated with only 12 per cent. of affected quarters.

As the severity of the mastitis increases and clots appear in the milk so does *Str. agalactiae* become the predominating organism. Nevertheless when all quarters showing clots, irrespective of their size and number are considered, the udder corynebacteria are still responsible for 14 per cent. of affected quarters. This percentage, however, drops to approximately 2 per cent. on an assessment of quarters showing multiple and large clots only.

A difficulty confronting research on mastitis is the determination of what constitutes mastitis. *Str. agalactiae, Str. dysgalactiae, Str. uberis* and the haemolytic staphylococci have been found by numerous workers in clinical cases showing macroscopic changes in the milk and are generally accepted as causal organisms. The position with regard to the non-haemolytic micrococci and the udder corynebacteria is different. The former may have been regarded with suspicion but the latter have not been suspected, probably because they are so frequently found in apparently normal milk, or when the milk is pathological in association with organisms accepted as pathogenic. The investigations now reported show this least suspected organism cannot be so lightly regarded. The udder corynebacteria, while they may be associated with but few cases of clinical mastitis, may nevertheless be held responsible for the appearance of increased numbers of cells, indicative of at least a mild inflammatory reaction in the infected quarter. Similar remarks hold good for the coagulase negative haemolytic staphylococci and the non-haemolytic micrococci. In this herd the infectivity of these two latter types of organisms was comparatively low, therefore their importance was less than that of the more ubiquitous udder corynebacteria.

No evidence was found that infection with one bacterium predisposed the quarter to infection with a more pathogenic bacterial infection. It is difficult to see how evidence on this point may be obtained from the field. It might, however, be decided by carefully conducted infection experiments, were sufficient numbers of experimental animals available, but the matter does not appear to have any practical significance as information, if obtained, could not be put to useful purposes in the field.

No evidence was found that the conformation of the free end of the teat or the presence or absence of eversion or erosion of the teat orifice exerted any influence on the susceptibility of the quarter to bacterial infection associated with mastitis. On the other hand, quarters classified as "easy milkers" had a higher incidence of mastitis than quarters classified as "hard milkers."

The incidence of mastitis in quarters that had been dry for less than 15 weeks was compared with the incidence of mastitis in quarters that had been dry for 15 weeks or longer. No difference was found.

A raised cell count in the milk before drying off materially increased the chances of quarters giving milk with clots early in the following lactation. Infection with *Str. agalactiae* or the coagulase positive haemolytic staphylococci at the end of one lactation was followed by a high incidence of quarters giving milk showing clots early in the following lactation. In comparison infection with the udder corynebacteria before drying off was followed by a much lower incidence of quarters producing milk with clots early in the following lactation.

The incidence of infection, and of mastitis associated with infection, with the mastitis streptococci and the coagulase positive haemolytic staphylococci increased progressively from the first to the third and later lactations. A similar trend was shown in the quarters infected with the udder corynebacteria but the number and percentage of quarters infected with the coagulase negative haemolytic staphylococci and the non-haemolytic micrococci did not increase in the later lactations.

Injuries to the teats and quarters and acute inflammation of quarters were recorded. A trend was observed for *Str. agalactiae* to infect the milk when the teat was injured. There was no evidence that superficial injury to the quarters rendered them any more susceptible to bacterial invasion. Quarters infected with either *Str. agalactiae* or the coagulase positive haemolytic staphylococci showed a higher percentage of acute inflammatory reactions than all other quarters. It may therefore be concluded that infection with one of the more pathogenic bacteria is generally already established when acute inflammation occurs.

Some workers have ignored the rôle that staphylococci, non-haemolytic micrococci and diphtheroid bacteria may play in mastitis. An increased number of cells in the milk or the appearance of clots in the milk cannot be accepted as evidence that mastitis may be caused by a filtrable virus or some unspecified cause unless a bacterial infection of the affected quarter can be excluded.

The control of bacterial infections of the udder is discussed under the headings, "eradication," "management and hygiene," "immunization" and "chemotherapy." It is considered that the eradication of *Str. agalactiae* infection from herds is a scientifically sound policy but its successful application would depend upon the adoption of an administrative policy that could only be justified on economic grounds, the consideration of which is beyond the scope of this paper. Chemotherapy might, however, be used in conjunction with an eradication policy and by curing infections in some animals reduce the number of infected cows, the elimination of which an eradication policy would demand.

The eradication of other types of bacterial infection from a herd is not considered practicable.

Management and hygiene have not been shown to exert any appreciable influence on the incidence of mastitis. Carefully conducted tests on herds kept for experimental purposes would be necessary in order to try to assess the part played by different methods of management and to determine systems of hygiene that might control or reduce the dissemination of the bacteria that infect the udder. It should, however, be appreciated that even under the best experimental conditions it would be optimistic to expect to demonstrate a reduction in the dissemination of udder bacteria in the cowshed.

Immunization, while presenting problems of scientific and academic interest, is unlikely to yield results that may be used successfully in the control of mastitis in the field. Little progress in knowledge will be made until a careful study of the problems involved is made and for these experiments cows maintained under conditions that will as far as possible exclude accidental bacterial infection of the udder will have to be used.

Chemotherapy at the present time holds out the best chance of mitigating the losses sustained from mastitis. Further efforts should be made to ascertain optimum chemotherapeutic practices.

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The Lord President of the Council has appointed Sir Frank Engledow, Chairman of the Food Investigation Board, Department of Scientific and Industrial Research, in succession to the late Sir Joseph Barcroft. Sir Frank is Draper's Professor of Agriculture at Cambridge and is 57.

* * * * *

Weekly Wisdom

Our relative freedom [from intestinal infections] is due to a high standard of sanitation, a careful supervision of public water and food supplies, and a comparatively high average standard of personal and family hygiene. The British are an untidy people, but they are not a dirty people."—Dr. John Drew ("Man, Microbe and Malady").

CLINICAL COMMUNICATION

The Clinical Use of Penicillin in the Treatment and Control of Bovine Mastitis

ROBERT G. MARES, M.R.C.V.S.
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E. B. Jones (*Vet. Rec.* **59**, 528) states that he finds the use of "intramammary infusion of penicillin in confirmed cases of *Strep. agalactiae* mastitis" to be "somewhat disappointing." Since the present writer's experience is to the contrary it is felt that an account of cases treated might be of value.

Treatment

Since the advent of penicillin records have been kept of 55 cases of mastitis treated with intramammary penicillin (calcium or sodium salts). Sulphanilamide has been given by the mouth simultaneously in many of the cases but it is felt that the results in general prove this to be unnecessary. The word "mastitis" for the purpose of this note is to be taken as covering all conditions causing either a clinical change in the milk or the presence of pathogens in the milk without a clinical change (*i.e.*, the mastitis carrier).

Various doses, concentrations and solvents were used at first and cures obtained using tap water as solvent. The dose used was never less than 50,000 units, the bulk of solution never less than 2 c.c. Different types of injector were also employed.

As experience was gained, however, a standard technique developed which is essentially that used and shown the writer by Mr. V. D. C. Farrant, M.R.C.V.S., in whose practice 35 of the cases have been treated.

Not every case encountered was considered suitable for penicillin therapy and it could be expected fairly confidently that as clinical discrimination increases the percentage of failures would decrease. It is felt that clinical discrimination is important to save the time and expense of bacteriological examinations and to arrest the disease processes as early as possible to avoid induration and loss of milk.

The number of acute cases encountered is too small to assess the value of penicillin therapy, but it is felt that it should be employed except in obvious cases of summer mastitis.

Method.—Mr. Farrant's method is as follows:—

Cheap, all-glass syringes of about 2 fluid oz. capacity are used and attached to teat siphons by short lengths of rubber tubing. One syringe is used per cow and one siphon per quarter. Distilled water is carried in sterile 2 oz. screw-top bottles; a small Record syringe is used for preparing the solutions from the vials and injecting it into the bulk of the solvent. Enough syringes and siphons are sterilized for the day's cases and packed in a clean container.

Dosage.—The dose is 100,000 units per quarter. This is larger than that used by many workers, but it is felt that under farm conditions it allows a safe margin for deterioration and contamination. Quarters have been treated successfully using any bulk of solvent from ½ to 2 fluid oz.

Treatment is repeated in 24 hours. Earlier cases were treated more often and once or twice an educated farmer was loaned a syringe and instructed to infuse at three or four successive milkings. A few cases were treated with a single injection. At least 30 of the cases have been treated as described above.

Results.—The results are set out in the table. "A" in brackets refers to the writer's own examination of incubated smears.* "Min. of Ag." in brackets denotes the findings of Mr. C. V. Watkins, M.R.C.V.S., D.V.S.M., Veterinary Investigation Officer. As cures have been obtained with all variations of treatment only the overall results have been summarized. Of 55 cases, 47 were successful, a percentage cure of just less than 85.

Control

Four of the chronic cases and four of the carrier cases listed in the table were members of a single herd of 14 cows. From July 15th, 1947, onwards, mastitis was appearing regularly in this herd in different animals or different quarters of the same animal. Only one cow did not respond to treatment and that proved to be suspicious of *C. pyogenes* in addition to *Strep. agalactiae*. After six successive cases in as many weeks, the farmer decided to have a herd test. Composite samples were therefore taken from each cow and submitted to a laboratory. The results were interesting. Only four of the samples were culturally negative and of these, three had been previously treated with penicillin. The fourth had

* These were prepared as follows: The milk was spun in a centrifuge and smears made from the deposits in the tubes. These were then protected from dust and left for 24 hours at room temperature; subsequently they were fixed, stained by Gram's method and examined.

Type of case	Number of cases	Incubated smear (Author) or Laboratory Report (Min. of Ag.)	Any other treatment in addition to penicillin		Bacteriological cures	Clinical cures	Presumed cures	Failed	Remarks
Clinical chronic Streptococcal mastitis	37	*Strep. agalact.* micrococci and "suggestion" of *C. pyogenes* (Min. of Ag.) 1	Sulphanilamide at first treatment				1		Relapsed at first treatment. Milk sample taken before second treatment
		Strep. chains in smears (A) 2	No response to sulphanilamide			1 (A)	1		
		Smears inconclusive (A) 2	Sulphanilamide simultaneously			2			
		No examination 32	Sulphanilamide	17	3 (Min. of Ag.)	7		2	One clinical cure after second attempt.
			No sulphanilamide	13		13			One relapsed after calving, but responded to sulphanilamide alone. One *Strep.* found in smear after no clinical response to treatment.
Clinical chronic *C. pyogenes* mastitis	2	*C. pyrogenes* in incubated smear (?) (A)				1			This is a very inconclusive case. Probably a strep. mastitis and contaminated smear.
		No examination	Sulphanilamide					1	Lost quarter. No other cases of *C. pyogenes* mastitis, chronic or acute (summer mastitis) have been treated with penicillin apart from the one below.
Acute mastitis	8	Mixed infection 1 (A)	Sulphanilamide with *Pyogenes* and *Staph.* toxoids	2				2	Death of both subjects from toxaemia.
		No examination 7	Sulphanilamide only	4		2		2	One died. One abscess of quarter.
			No other treatment	2		1		1	One cured with a single injection of 100,000 Units. One lost quarter (summer mastitis).
Mechanical infections (Lay interference Bougies, etc.)	3	No examination	Sulphanilamide			3			
Carrier cows	5	*Str. agalactiae* in smears or culture (Min. of Ag.)			1		4		Cures "presumed" because no further outbreaks in herd after treatment of carriers detected in herd test.

never given any trouble. Two cows previously treated revealed *Strep. agalactiae*, one being that mentioned above as not responding, the other having had two successive treatments in two separate quarters. It is believed that this cow was a carrier in one of the untreated quarters. Three other cows whose milk was clinically normal when sampled revealed *Strep. agalactiae*. *B. coli* was found in two samples and "micrococci" in four.

The five cows harbouring *Strep. agalactiae* were treated with 100,000 units of penicillin in ½ oz. distilled water per quarter repeated in 24 hours on September 14th. Since that day no further trouble has occurred in the herd.

Two other herds have been tackled in this way by Farrant and his visits to them to treat mastitis have virtually ceased in consequence.

Conclusions

(*a*) Intramammary infusion of penicillin is a most successful means of treating mastitis.

(*b*) The detailed methods of infusion may be varied to suit the requirements of individual operators without affecting the results.

(*c*) Clinical discrimination of cases likely to respond is possible.

(*d*) Sulphanilamide by the mouth is not a necessary adjunct to the treatment.

(*e*) With the aid of a laboratory, infection due to *Strep. agalactiae* may be virtually eliminated from the herd.

Acknowledgments.—To E. F. Lewis, M.R.C.V.S., Surgeon-in-Charge, Royal Veterinary College practice, Steyning, Sussex, and to V. D. C. Farrant, M.R.C.V.S., in whose practices the cases were treated and recorded. Also to C. V. Watkins, M.R.C.V.S., D.V.S.M., for laboratory examinations and report.

REVIEW

["The British Journal of Nutrition." Vol. 1, No. 1, Sept., 1947.]

It is a pleasure to welcome a new British journal devoted entirely to nutrition. The pleasure would have been greater had it been possible to see an article by Sir Frederick Gowland Hopkins, the founder of the British School of Nutrition, instead of the inspiring, but nevertheless sad, obituary. There is also a tribute to Sir Joseph Barcroft, the leader in numerous fields of physiological research, many of them of particular application to veterinary science.

Nutrition being a clinical subject, as much as a laboratory one, it is good to notice the catholic range of articles in the first number of the new journal, which contains original papers dealing with the estimation of ascorbic acid in the presence of interfering substances, with the composition of sow's milk, and with the formation of fluorescent pigments in the tissues of vitamin E deficient rats. In a number which contains a reference to Gowland Hopkins' work, it is of interest to note a group of workers still failing to find purified diets, supplemented by no less than twelve vitamins, satisfactory for the growth, reproduction and lactation of rats. The present trend in our rations gives increased interest to an analysis of English prison diets in 1944.

In the "Proceedings of the Nutrition Society" is an interesting series of articles dealing with "Education in Nutrition." With world conditions, such as are likely to be for some years to come, the spread of nutritional knowledge is very necessary. That knowledge may have to be expressed in simpler language as it passes from specialist to teacher and thence to the housewife, but spread it must certainly be.

In addition to the articles and original papers mentioned above there are a number of interesting abstracts of communications to the Nutrition Society. Of these, a study of the stimulation and growth of fattening pigs by synthetic oestrogens, the nutritional variation of soils and pastures on Scottish hill grazings, the intestine as a possible seat of conversion of carotene to vitamin A in the rat and the pig, and the effect of yeast on liver size and vitamin A storage in the pig, are subjects of interest to veterinary workers.

The British Journal of Nutrition is published by the Cambridge University Press for the Nutrition Society, which owns it and controls its publication. It is devoted to reports of original work in all branches of nutrition. A volume will consist of four parts appearing at quarterly intervals. For non-members of the Nutrition Society the subscription to the journal is £3 per volume (including postage), payable in advance to the Cambridge University Press, 200, Euston Road, London, N.W.1, or to any bookseller.

It is to be hoped that future numbers of this valuable periodical will have as wide a range of articles as the first.

ABSTRACTS

[The Control of the Sheep Blowfly with DDT and Benzene Hexachloride (666). Hughes, L. E., Pollard, E. P., Field, H. I., & Jones, J. M. (1947.) *Vet. J.* **103**. 265-273.]

In an investigation covering nine farms in Central Wales, sheep dipped in suspensions of DDT and benzene hexachloride and a commercial arsenic and sulphur dip were examined for resulting control of sheep blowfly attack. All the dips were used on every farm, and immersion was for about 20 seconds. DDT was used at a dilution of 1 in 200 and benzene hexachloride at 1 in 200 giving a concentration of its active insecticidal agent (the gamma isomer)* of 1 in 1,600. The arsenical sulphur dip contained 0·19 per cent. As_2O_3 (1 in 526).

The results from eight farms gave totals of between 859 and 1,093 sheep on the different dips.

It was concluded that, at the dilutions used, DDT was the most efficient dip tested, giving far greater protection than benzene hexachloride or arsenic. On those farms observed for 46 days the average duration of protection was for DDT 42 days and the other dips 30 days, but on farms observed for 33 days the figures were DDT 32 days, arsenic 26 and benzene hexachloride 22 days.

All three gave much better protection against body strike than breech strike, to prevent which "crutching" is necessary to minimize soiling of wool by faeces.

**Note by Abstractor.*—It is very necessary to express the results of insecticidal tests with benzene hexachloride in its gamma isomer content which varies according to the method of manufacture, etc. Thus, in this paper and that abstracted below, concentrations of benzene hexachloride at 1 in 200 would mean respectively one part of the gamma isomer in 1,600 parts of diluent, and in the other (Cobbett's), one part of the gamma isomer in 600. Up to date it is only the gamma isomer which has shown substantial insecticidal activity and unless authors' results are clearly based on gamma isomer content endless confusion will ensue.

J. S. S.

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[Preliminary Tests in Mexico with the DDT Cube, Hexachlorocyclohexane (benzene hexachloride) and Combinations thereof, for the Control of Cattle Fever Tick, *Boophilus annulatus.* Cobbett, N. G. (1947.) *Amer. J. vet. Res.* **8**. 280-283.]

Mexico provides ideal conditions for the one host cattle tick, *Boophilus annulatus*, and cattle dipped in the approved arsenical dips soon become reinfested. Furthermore, repeated dippings in arsenical solutions require great care in hot climates to avoid blistering, etc. In the present tests, DDT (technical), cube powder (4·4 per cent rotenone content), and benzene hexachloride (30 per cent. gamma isomer) were used. The first and last were dissolved in xylol or benzol and emulsified in soluble pine oil or soluble petroleum oil. Water was then added and the mixture emulsified.

Application was by coarse spray at 40 lb. pressure to ensure thorough wetting of the whole body surface and 5 gallons per beast was found sufficient.

DDT at a dilution of 1, 1½ and 3 parts per 100 killed all but a few female ticks within 24 hours. It remained toxic for newly attached ticks for at least two weeks. The combination of DDT and cube gave no improvement. One and 5 parts per 100 of cube killed all ticks, except adult females, in 24 hours—many of these survived and this preparation had little residual activity. Benzene hexachloride was used at dilutions containing ¾, 1¼ and 3 parts per *thousand* of the gamma isomer. All ticks were killed by the two higher concentrations and all but a few adult females by the lowest. The residual effect of this substance was rather less than that of DDT at the higher concentrations used. The combination of DDT (0·25 per cent.) and benzene hexachloride, 0·25 per cent. (= gamma isomer content of 0·075 or 1 part in 1,250) killed all the ticks with a residual toxicity for newly attached larvae of about three weeks.

The control treatment with regular arsenical dip (0·19 per cent. arsenic) had little residual activity.

J. S. S.

Erratum.—"Poliomyelitis and Virus Disease of Dogs," E. G. Wood, *Vet. Rec.* **59**. 654, col. 1, para. 2, of letter: *for* "Arising in dogs and horses" *read* "Arising in dogs and houses."

REPORTS

The Lucas Report

The report of the Committee presided over by Lord Lucas of Chilworth is issued as No. 48 of the series of reports on Agricultural Marketing (H.M.S.O., 2s.). The National Veterinary Medical Association sent a memorandum for the consideration of the Committee, while its representatives gave verbal evidence.

The principal recommendation is, in effect, that marketing policy should be dictated neither by a Civil Service Department nor by a Statutory Board controlled by producers. Instead, independent bodies, called Commodity Commissions, should be set up, resembling Public Utility Corporations and financed out of public funds. For some commodities, such as livestock and meat, a main Commission with a number of sub-Commissions is suggested.

The members of Commodity Commissions would be essentially "the business executives of the taxpayer," and not of producers or of other sectional interests. It is appreciated, however, that a link between the latter and the Commodity Commissions is desirable, and accordingly separate Advisory Committees would be nominated by producers, processers, wholesalers and retailers. In the case of livestock and meat, a committee consisting of veterinary surgeons would advise the Commission.

It is suggested that the relevant Commission might need to reorganize completely the present slaughtering arrangements, establish factory abattoirs, each to deal with a minimum of 3,000 head per week, ensure that full use is made of all by-products, and eliminate unnecessary profit margins at all stages of marketing of meat. Further suggestions include quality-grading for home-produced meat, the diversion of poor quality meat to manufacturing, and the trial of new methods in selling meat, such as supplying retailers with pre-packed joints direct from the factory abattoir.

The Lucas Committee suggest that the old style producers' Marketing Boards should function in a limited field, carrying out: co-operative buying of feeding-stuffs, provision of beef bulls for artificial insemination, and the settling of contracts for transport to the collecting centres.

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[Uganda Protectorate Veterinary Department. Report for the year ended December 31st, 1945.]

The livestock census of the Eastern, Western and Buganda Provinces totalled approximately two and a quarter million cattle, two and a quarter million goats, one million sheep and 23,000 pigs.

The department was able to meet all emergencies and maintain the livestock trade despite serious depletion of European staff and severe drought early in the year.

Anti-tsetse measures directed by a committee, of which the D.V.S. is a member, set up in 1944, have apparently succeeded in stemming tsetse advance in Northern Buganda Province and have even caused an eight-mile retreat of the fly (*Pallidipes*) in one area. The tsetse problem is linked with animal trypanosomiasis (*T. congolense* and *T. vivax*) which killed 11,000 cattle in 1944. Phenanthridinium 1553 in doses of 1 mg. per kg. in a 1 per cent. solution intramuscularly into the thigh gave very promising results, but the most effective method of use is still the subject of research.

Rinderpest gave comparatively little trouble, only two outbreaks occurring in the Protectorate except in the Karamoja District where it is endemic and control measures have never been attempted owing to administrative difficulties. Contagious bovine pleuropneumonia was reintroduced into Mbale District, which had been free since 1924, by the return of stolen cattle from Karamoja. The slaughter of four herds and inoculation of 3,000 cattle in the surrounding zone stopped further extension, but the general position still causes anxiety. East Coast fever and other tick-borne diseases continue to cause considerable economic loss owing to high calf mortality and retarded growth. Emphasis is laid on the value of good calf management in lessening the effects.

The report mentions Kyoga skin disease which apparently does not spread in the usual way and attacks only a small percentage of cattle in each herd.

The Livestock Industry section reveals how high prices had encouraged the export of cattle from the main producing areas to a most dangerous degree, and the restrictions which became necessary to conserve supplies. Similar control was imposed on the export of poultry. The goat trade was maintained at a high level, over 600,000 being slaughtered. Pig breeding is chiefly confined to Buganda Province where it is increasing. The volume of trade in poultry and eggs showed a marked rise. The great demand for milk resulted in adulteration, control of which was difficult owing to the number of middlemen involved. Uganda now exports a considerable quantity of ghee to Kenya whereas she formerly imported 250 tons a year. The decrease in the number of cattle slaughtered involved a reduction in the export of hides and skins in which there was a drop of 143 tons of hides and 18,000 skins as compared with 1944. Follicular mange is one of the chief causes of down-grading of hides.

Considerable improvement in the standard of Animal Husbandry is recorded, especially in Buganda Province where owners are taking more personal interest in the management of their stock, instead of leaving it to ignorant and tradition-bound Bahima herdsmen. The Veterinary Department advises owners in all parts of the country. The shortage of bulls is a major problem.

A considerable proportion of the Laboratory's research work was devoted to Trypanosomiasis, including the life history of *Trypanosoma congolense*. Mr. Fiennes showed the main habitat in bovines to be in the skin or its small capillaries, and describes a form of cyclic development with production of micro- and macrogametes. Mr. Bell demonstrated that severe photosensitization, which might prove fatal, followed large doses of phenanthridinium 1553. Mr. Randall worked on the dosage and administration of this compound, and the effects of minimal repeated doses of phenothiazine upon *Strongyloidea* spp. in calves and sheep.

At the Veterinary School nine students were in residence throughout the year. The results in the final examinations were particularly good.

G. B.

IN PARLIAMENT

Book Import (Restrictions)

In the House of Commons on Thursday of last week, on the motion for the adjournment,

Mr. Hollis raised the question of the import of books. He said that from the purely financial point of view greater freedom of trade in books with the United States of America would result in a more favourable, rather than a more unfavourable, dollar situation. Nevertheless, it would be intolerable that one of the greatest glories of this country, her literature, should be considered solely as an article of commerce. He was extremely concerned about the whole import licensing system and by no means entirely consoled when the President of the Board of Trade said that the system would be operated in such a way as to let in any books of value. He saw no reason why this President of the Board of Trade or any other should be the judge of what was valuable literature.

He had not heard of any scandals in regard to licences being refused, but there was cause for complaint about the intolerable delays which took place in granting licences. It was fantastic to say that we must have more exports and yet to stop allowing imports and to think that other countries would take our goods if we took nothing from them. The most important exports of this country for generations had been not coal or cotton but ideas. The danger was that around this country and other countries there might be growing up something in the nature of an intellectual iron curtain.

The people of this country were stopped from travelling abroad, newspapers were cut down, and if imports of books were stopped more and more the nations would drift into separate compartments. Our literature could not flourish if we retreated into intellectual isolation. At the moment all work of scholarship was becoming increasingly hampered by the fact that scholars could not get hold of the most important works in their various fields produced in other countries.

Mr. Wyatt pleaded for the removal of the limit on the number of scientific and technical books which can be imported, in the interest of the prosecution of research, and Mr. Mitchison, supporting, stressed the damage being done by inhibiting the free flow of knowledge. Mr. Wilkes said that one of the most serious factors in the present situation was the shortage of medical textbooks: there was a grave danger of our falling behind others in medical teaching and practice. Mr. Janner, looking upon the matter in the light of the recommendations of the Barlow Commission, said that the number of scientific books, even in so far as the basis of pre-war supply was concerned, must be increased.

Mr. Belcher, Parliamentary Secretary to the Board of Trade, said he was not a Philistine in this matter. He was anxious to do all he could to secure the most adequate supply of books to this country and from this country to other nations. Within the limitations of shortages of materials and labour the Government were doing all they could to stimulate the free flow of knowledge between this country and other countries. It was extremely difficult, even with the best will in the world, to justify action which would increase the importation of books from America when the nation was having to suffer reductions in its staple foods. He would look into the question of books being imported from America at the expense of dollars and re-exported to soft currency countries.

He did not think it would be wise for the Board of Trade to set themselves up as judges in these matters. It was in many respects a matter of taste. He could not accept that dollars earned by British books should be equated by the purchase of American books. Dollars must be used to buy food and raw materials. He looked forward to the time when it would be possible to send our books abroad and bring in more books from other countries.

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Position of Foreign Doctors Regularized

On December 5th the Bill which regularizes the position in Great Britain of doctors with foreign qualifications, was given its second reading, being supported by all parties.

Moving this reading of the measure—the Medical Practitioners and Pharmacists Bill—the Minister of Health said that doctors with foreign qualifications, allowed to practise in this country under Defence Regulation 32b during the war, would be unable to continue to practise after December 31st this year unless their position were regularized. The Bill would regularize the position of these doctors on the temporary register and enable them to practise in the same way as British doctors with the ordinary British qualifications. There would be about 3,500 such doctors when the register closed, but he did not believe that all would want to remain. It was estimated that between 1,500 and 2,000 would want to avail themselves of the facilities afforded by the Bill. Polish doctors brought here under the Polish Resettlement Scheme numbered about 200 and it was expected this figure would have increased by the end of the year.

Provision was also made for foreign doctors who served with our forces oversea and on demobilization had been permitted to enter the United Kingdom. Special arrangements would be made to deal with doctors attached to the Polish forces who could not be in this country before the end of the year. He proposed to introduce an amendment in Committee to enable doctors attached to our establishments abroad to practise in this country.

Following supporting debate, Mr. Bevan said that the medical profession had benefited enormously from the doctors who had had to flee from other countries and come here. We needed more facilities for post-graduate medical training in this country and in the Commonwealth generally.

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Questions

Unregistered Veterinary Surgeons

Mr. G. Williams asked the Minister of Agriculture when the Government expect to implement their intention to introduce legislation concerning unregistered veterinary surgeons on the lines proposed by the Chancellor Committee.

Mr. T. Williams: I am unable to say at present.

Mr. G. Williams: Is the right hon. Gentleman aware that many of these unregistered veterinary surgeons are being victimized by this long delay, and will he hurry the matter up?

Mr. T. Williams: I could not agree with the hon. Gentleman more, but we have been in constant negotiation with the various interests, and I shall be as happy as he when it is possible to introduce the Measure.

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Fowl Pest

Mr. Hurd asked the Minister of Agriculture if his scientific advisers are completely satisfied that the import restrictions on poultry are effectively preventing the further introduction of fowl pest infection from the Continent.

Mr. T. Williams: There must always be some risk in importing poultry carcases from countries where fowl pest is known to exist, but my advisers are satisfied that the present arrangement, by which only eviscerated carcases (with head and feet removed) are imported from Europe effectively reduces the risk to a minimum. There is no evidence that any outbreak of fowl pest in Great Britain has been caused by imported poultry from Europe since the imports have been confined to eviscerated birds.

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Drugs (Purchase Tax)

Sir E. Graham-Little asked the Chancellor of the Exchequer if he is aware that the increase effected by the interim Budget in the Purchase Tax on drugs which are in constant use by medical practitioners will be a handicap upon their prescribing and must constitute a burden upon the chronic sick; and if he will consider enlarging, on medical advice, the list of drugs to which exemption is granted.

Sir S. Cripps: Certain essential and costly drugs used in prescribing medicines are already exempt, and I doubt whether the raising from 16⅔ to 33⅓ per cent. of the Purchase Tax on those materials which are chargeable will operate in the way suggested to any serious extent. However, I am considering proposals for extending the list of exempt drugs, in consultation with my right hon. Friend the Minister of Health.

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Dog Licences

Mr. Sparks asked the Postmaster-General how many dog licences were issued by post offices in 1938 and 1946; what was the cost of an individual licence in those years and the revenue arising therefrom; and whether he contemplates a further increase in the licence fee.

Mr. Wilfred Paling: The figures were:—

		Licences issued	*Revenue* £ s. d.
1938	...	2,995,301	1,123,237 17 6
1946	...	2,625,400	984,525 0 0

The cost of a dog licence in 1938 was 7s. 6d. and it has not since been changed. I am not aware that any increase is contemplated, but this is not a matter for the Post Office.

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Horses (Docking)

Mrs. Manning asked the Secretary of State for the Home Department whether he will take steps to prevent the continued cruelty of docking the tails of horses, a painful operation that deprives these animals of their only means of defence against flies in the summer.

Mr. Ede: I am advised that legislation would be required, and regret that no time is at present available for the purpose.

NOTES AND NEWS

Diary of Events

Dec. 13th.—Meeting of the Biochemical Society, London School of Hygiene, Keppel Street, W.C.1, 11 a.m.

Dec. 19th.—Meeting of the Association of Veterinary Teachers and Research Workers (Northern Region) at the University of Liverpool Veterinary Field Station, Leahurst, Neston, Wirral, 11 a.m.

Dec. 18th.—Meeting of the North of England Division, N.V.M.A., at Newcastle-on-Tyne (Agricultural Department, King's College), 2 p.m.

Dec. 31st.—Latest date for changes of address to be notified to the Registrar, R.C.V.S., for inclusion in the 1948 Register.

Jan. 6th, 7th, 8th and 9th, 1948.—Quarterly and special meetings of Council, R.C.V.S., 10, Red Lion Square, W.C.1.

Jan. 10th.—First Annual General Meeting of the Association of Veterinary Teachers and Research Workers (Southern Region) at the Royal Veterinary College, N.W.1, 11.30 a.m.

Jan. 14th, 15th and 16th, 1948.—Meetings of Committees and Council, N.V.M.A. Committees at 36, Gordon Square, W.C.1, Council (16th) at the Connaught Rooms, Great Queen Street, Kingsway, W.C.2.

Feb. 19th and 20th.—Special meetings of Council, R.C.V.S., 10, Red Lion Square, W.C.1.

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Jury Service

The Registrar of the Royal College of Veterinary Surgeons finds that many members are unaware of the present position regarding Jury Service. Unfortunately, under the existing law, Veterinary Surgeons are not exempt from Jury Service. The position is that their names must be placed, if eligible, on the Jury Lists and summons for service may be received.

If this occurs a member should immediately write to the authority sending the summons, asking for release from service on the grounds that he is a Veterinary Surgeon (and that he is single-handed if that is applicable) and giving any other details which would show that his continued absence from practice for several days would be detrimental to the agricultural policy of the nation, or to the relief of animal suffering.

Any member who receives a summons should immediately communicate with the Registrar, R.C.V.S., or the General Secretary, N.V.M.A., giving the name and address of the authority issuing the summons, and the date for which the member is called for Jury Service.

Use of Petrol

Approval for Social and Recreational Purposes if "On Call"

It became clear some weeks ago that the Government's decision to discontinue the basic petrol ration would cause serious hardship to members of the medical and veterinary professions. Medical and veterinary practitioners are in a different position from other members of the community in that they are normally on call to their patients at all times of the day and night. Indeed, the practitioner has become increasingly dependent upon his motor car and he is able to take a few hours relaxation from his practice only because his car and essential medical equipment are immediately available to take him to an emergency call.

Naturally the medical and veterinary professions are expected to share with other sections of the community any hardships which arise from the measures of retrenchment which are necessary in the national interest but it is inequitable that doctors and veterinary surgeons, because of their calling, should be denied some measure of social and recreational relaxation.

It was accordingly represented to the Minister of Fuel and Power that a doctor or veterinary surgeon, when on reasonable call to his patients, should be permitted to use his car for any purpose. The Minister has recognized the special difficulties with which doctors and veterinary surgeons are faced though he has not been able to agree that they, as a class, should be subjected to no form of restriction in the use of petrol obtained on supplementary coupons. He has, however, agreed that if a doctor or a veterinary surgeon undertakes a social or recreational engagement and is at that time on call to his patients, it would be reasonable for him to use his car in order that he might get to a case with the minimum of delay. In these circumstances, however, the practitioner must be able to justify his action if challenged by the police. No practitioner could justify the use of his car in circumstances where he had made alternative arrangements for his patients. Where a doctor or veterinary surgeon using his car can show that he is on call to his patients and has taken steps to ensure that a message to which he can respond without delay can readily reach him it would, in the Ministry's view, be sufficient explanation that his car was being used in connection with his professional duties. Regional Petroleum Officers will be informed by the Ministry of these arrangements. It is understood that the Police would not take any proceedings without prior consultation with the Regional Petroleum Officer. It will be appreciated that the Regional Petroleum Officer would not be in a position to express an opinion whether a practitioner was in fact "on call" in any particular circumstances.

The Association has also learnt that Regional Petroleum Officers have been instructed that petrol may be allowed to veterinary surgeons for the purpose of attending meetings of the Association and other professional meetings in the locality. Where, for this purpose, the journeys involved are considerable the Regional Petroleum Officer will consult the Veterinary Liaison Officer as to the special importance of the meetings. The Ministry has agreed to look into any case where petrol has been refused for these purposes.

Members who wish to affix a "Veterinary Surgeon" sign to the windscreen of their cars will wish to know that suitable labels are now in the hands of the printers. As soon as they are available they will be issued, by the General Secretary, N.V.M.A., on application to 36, Gordon Square, W.C.1.

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PERSONAL

Marriage.—Johnston—Haddow.—At the Memorial Chapel, Glasgow University, on November 15th, 1947, William G. Johnston, M.R.C.V.S., Waverley Drive, Wishaw, to Eleanora J. Haddow, M.B., Ch.B., Dryburgh Road, Wishaw.

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Birth.—Wilkins.—On November 29th, 1947, at Ormond Lodge Nursing Home, Bath, to Peg, wife of Major J. H. Wilkins, R.A.V.C., of Brewery Cottage, Southstoke, Bath—a son.

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VETERINARY EDUCATIONAL TRUST

Estate Acquired for Livestock Research

As a result of negotiations which have been in progress during recent months the Veterinary Educational Trust has purchased from Dr. H. A. C. Gregory the Houghton Grange Estate, near St. Ives, Hunts., on which will be developed a group of Research Stations to handle the problems of farm livestock—cattle, sheep, pigs, goats, poultry, etc. The estate comprises over 900 acres and additional adjoining land is available which the Trust will probably take over in due course.

With the Equine and Canine Stations already in being at Newmarket, this latest acquisition completes the Trust's plans for the provision of Research Centres and when the adaptation and equipment of buildings has been completed and the requisite scientific and lay staff secured, the Trust will be in a position to go ahead with all branches of its research work.

First of the Stations to be opened at Houghton Grange will be the Poultry Centre and it is likely that it will commence work early in the New Year. A representative Poultry Committee will be established at V.E.T. headquarters to secure the widest possible support for its operations. Already four scientific officer posts have been advertised for this Research Station.

The work of the Stations at Newmarket and St. Ives will be supervised by a Scientific Directorate, comprising the Directors of the individual Research Stations and one or two outside scientists, under the chairmanship of Dr. Wooldridge. This Directorate will ensure that the scientific staffs in the various units co-ordinate their research activities and give to each other the greatest possible assistance and stimulus. Similar centralized arrangements are being made for handling the administrative side of their activities and the Trust is appointing a Farm Manager to deal with agricultural activities at the Stations.

Dr. Gregory, the owner of Houghton Grange, and his wife, who is also a doctor, hope to collaborate actively with the Trust's research staff when appointed, as they are both keenly interested in the work to be done on the diseases of farm animals.

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Films of Veterinary Interest

On November 19th last, the Veterinary Educational Trust, acting in association with Imperial Chemical Industries, Ltd., arranged the showing of two I.C.I. films: Phenothiazine, and Sterility in Dairy Cattle. The first pleaded, eloquently and convincingly, the need for anthelmintic treatment in farm animals and showed the convenience and efficacy of phenothiazine. The second, entirely free from advertising matter, pictured in a most lucid and interesting way the various causes of sterility and their treatment. It might be described as an educational film of the first quality.

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Mr. J. S. J. Lauder, M.R.C.V.S., Altrincham, through an appeal, has raised £150 for the Veterinary Educational Trust which is establishing a canine research station near Newmarket.

Other contributions to the Trust include £100 from Brighton Dog Show; £100 from Mr. R. L. Pilkington, Hinchwick, Stow-on-the-Wold; £5 15s. 9d. from Southampton Canine Society and £5 5s. from Linslade Horse Show, while the Bloodstock Industry Committee has received cheques for £250 from Hurst Park Club Syndicate and the Steeplechase Company, Cheltenham, Ltd. Fagley Horse Show Committee (Bradford) has sent £5.

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MINISTRY OF AGRICULTURE APPOINTMENTS

The following announcement is made by the Ministry of Agriculture and Fisheries:—

The Minister of Agriculture and Fisheries has accepted with regret the resignation as from December 31st, 1947, of Sir William Gavin, C.B.E., who has been Chief Agricultural Adviser to the Ministry since the outbreak of war.

Professor J. A. Scott Watson, C.B.E., LL.D., has been appointed from January 1st, 1948, to be the Ministry's Chief Scientific and Agricultural Adviser and Director-General of the National Agricultural Advisory Service.

Mr. Robert Rae, B.AGR., who has been serving as an Under Secretary in the Ministry, has been appointed, from January 1st, 1948, to be the Director of the National Agricultural Advisory Service.

Mr. F. Grant, O.B.E., Principal Assistant Secretary, has been appointed to be an Under Secretary of the Ministry from January 1st, 1948.

Mr. H. G. Lambert, Principal, has been placed in charge of a new Branch to organize the special campaign for Grassland Development that was recently announced by the Minister as part of the new Agricultural Expansion Programme. It was announced on November 15th that the Technical Officer in charge of the campaign is Mr. W. H. Hay, B.SC.

DR. N. C. WRIGHT'S APPOINTMENT AS SCIENTIFIC ADVISER TO THE MINISTRY OF FOOD

Dr. N. C. Wright, Director since 1928 of the Hannah Dairy Research Institute, Ayr, has recently been appointed to succeed Sir Jack Drummond as Scientific Adviser to the Ministry of Food, being seconded during the period of this appointment from the directorship of the Institute. In its issue of November 15th *Nature* recalls that Dr. Wright is a graduate of Oxford, and during his post-graduate training, carried out research in biochemistry at Cambridge, at the National Institute for Research in Dairying, Shinfield, and in the United States, where he held a Commonwealth Fund Fellowship during 1926-28. While at Shinfield, he investigated, with Mr. W. L. Little, the aetiology of milk fever in cattle. These investigators were the first to point out the fall in blood calcium accompanying this disease, a discovery which laid the foundation for the modern method of treatment. Dr. Wright was appointed first director of the Hannah Institute in 1928, and the noteworthy progress of that Institute has been largely due to his efforts. He and his collaborators have, among other researches, examined the influence of heat on the behaviour of milk proteins, the mechanism of the secretion of calcium, phosphorus and other milk constituents by the mammary gland, the differences in biological value for milk secretion of various mixtures of food proteins in common use in the rations of dairy cows, and they have made valuable contributions to knowledge in each of these fields.

Dr. Wright has also in recent years studied the questions, at present of great national importance, of the feeding-stuffs requirements of farm animals in relation to home and overseas supplies, and the rival claims, under war-time conditions in Britain, of animals and man for food. His appointment at the Ministry coincides in time with the agricultural expansion programme for greater home production of food, a programme which largely depends for its implementation on the increased importation from overseas of animal feeding-stuffs. Dr. Wright's recent studies will doubtless be of especial value in relation to this importation, which is a function of the Ministry of Food. Since 1936 he has paid several advisory visits overseas: to India, the Middle East, Ceylon, and recently to Greece with a mission of the United Nations Food and Agriculture Organization, mainly in connection with food production and livestock problems.

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ADDRESSES OF DISEASE-INFECTED PREMISES

The list given below indicates, first, the country in which are situated the premises on which disease has been confirmed, followed by the postal address and date of outbreak.

SHEEP SCAB:

Brecon.—Gudder Farm, Llanbedr, Crickhowell, Brecon; Cwmgufach Farm, Tretower, Crickhowell, Brecon; Pencaecrwn Farm, Cwmdu, Crickhowell, Brecon; Tycunfin Farm, Tretower, Crickhowell, Brecon; Pentwyn Farm, Cwmdu, Crickhowell, Brecon (Dec. 1st); Gwernvale Farm, Crickhowell, Brecon (Dec. 2nd).

Denbigh.—Ffrithoedd, Cerrig-y-Druidion, Corwen, Merioneth (Nov. 28th); Pant-yr-Onn, Llanelidan, Ruthin, Denbighshire (Dec. 12th, 1947).

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H.M. STATIONERY OFFICE PUBLICATIONS

The undermentioned have been published recently. Copies can be purchased through any bookseller, or directly from H.M. Stationery Office.

	Price net	*Post free*
	s. d.	*s. d.*
HOUSE OF COMMONS BILLS (Session 1947-48):		
20 Medical Practitioners and Pharmacists (H. L.)	0 3	0 4
STATUTORY RULES AND ORDERS, 1947:		
2555 Poisons (Amendment) Rules. Nov. 28th ...	0 1	0 2

CORRESPONDENCE

The views expressed in letters addressed to the Editor represent the personal opinions of the writer only and their publication does not imply endorsement by the N.V.M.A.

Correspondents should write as briefly as possible and letters should not exceed 350 words.

WAS IT *PENICILLIUM NOTATUM*?

Sir,—I have a clear recollection of the incident described by Mr. Lishman in *The Veterinary Record* of November 29th.

For me there was an interesting sequel. In 1928, shortly after my connection with the College had been severed, I was at St. Mary's Hospital for the purpose of arranging contact between a worker who required a large number of samples of bovine blood and Mr. Hayhurst at the Islington Cattle Market. I was introduced to Dr. Fleming, as he was then, who drew my attention to the original plate cultures showing the phenomenon observed and commented upon by Sir John M'Fadyean in 1905.

Yours faithfully,

Wroxton, Chorleywood, Herts. A. LESLIE SHEATHER.

December 4th, 1947.

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DOSAGE OF SULPHAMEZATHINE IN PIGLETS

Sir,—Mr. F. A. Chapman, in your issue of November 22nd, reported that a dose of 15 c.c. of a 16 per cent. solution of "Sulphamezathine" given subcutaneously once daily had a marked curative effect in an outbreak of polyarthritis in piglets. A dose of 30 c.c., however, produced toxic symptoms.

He states that the original dose of 30 c.c. was calculated from N.V.M.A. Publication No. 10. In that publication the dose recommended for oral use is 0·2 gramme per kilogram followed by 0·1 gramme per kilogram once daily. The dose of 30 c.c., however, contained 4·8 grammes of the drug and was given to pigs which could hardly have weighed more than 5 kilograms, *i.e.*, at a rate of nearly 1 gramme per kilogram. Thus it is not surprising that toxic effects were produced.

It has been shown by Francis (1947a and b) that "Sulphamezathine" produces better blood levels than any other sulphonamide in the pig and a dose of 0·1 gramme per kilogram subcutaneously produces a maximum level of 11 milligrammes per cent. (*i.e.*, a therapeutic level) for 24 hours.

It would appear, therefore, that the appropriate dose for a sucking pig would certainly not be larger than one half to one gramme daily, assuming that the pig weighed 5 kilograms (11 lb.). The dose of a 16 per cent. solution would therefore be 3 to 6 c.c. With this dose there appears to be a wide margin of safety.

It is interesting to note that no irritant effect was reported following the injection of 15 c.c. doses, although it is, of course, established that the sodium salt of "Sulphamezathine" is less irritant than the sodium salts of the other sulphonamides.

References

FRANCIS, J. (1947a) "Some Observations on the Pharmacology of the Sulphonamides and 4:4'-Diaminodiphenylsulphone in the Domestic Animals." *Vet. J.* 103. 193-207.

——. (1947b.) "Studies on *Str. agalactiae* Infection." I-IV. *J. comp. Path.* 57. 144-173.

Yours faithfully,

Imperial Chemicals (Pharmaceuticals), Ltd., W. T. HARROW.
Veterinary Department,
The Ridge,
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Alderley Edge, Manchester.

November 28th, 1947.

DISEASES OF ANIMALS ACTS, 1894 TO 1937, AND AGRICULTURE ACT, 1937 (PART IV).

Summary of Returns of Confirmed Outbreaks of Scheduled (Notifiable) Diseases

Period	Anthrax	Foot-and-mouth	Fowl Pest	Parasitic Mange*	Sheep Scab	Swine Fever
Nov. 1st to 15th, 1947	7	—	397	—	—	2
Corresponding period in—						
1946	5	1	—	—	11	4
1945	7	4	—	—	5	22
1944	9	22	—	—	29	65
Jan. 1st to Nov. 15th, '47	104	103	1,797	1	74	33
Corresponding period in—						
1946	82	35	—	7	85	336
1945	110	123	—	6	108	867
1944	163	156	—	7	206	1,265

NOTE.—The figures for the current year are approximate only.
* Excluding outbreaks in Army Horses.

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CHRISTMAS ARRANGEMENTS

Messrs. Bayer Products, Ltd., wish to advise their veterinary clients that their offices at Africa House, Kingsway, W.C.2, will be closed on Friday afternoon, December 19th. They will also be closed from the 25th-28th inclusive. Drugs urgently required when the Bayer offices are closed can be obtained from Messrs. John Bell and Croyden, 50, Wigmore Street, London, W.1.